SCIENCE ABSTRACTS.

Section A.—PHYSICS.

MARCH, 1929.

GENERAL PHYSICS.

652. Studies in Clocks and Time-Keeping: Present-day Performance of Clocks. R. A. Sampson. *Roy. Soc. Edinburgh, Proc.* 48. *Part II. pp.* 161–166, 1927–1928.

Two Shortt clocks, SH0 and SH4, have been compared daily by means of a special microchronograph to 0·001 sec. over a period of a year. The true daily error of SH4 was also determined daily with the transit instrument. After eliminating all predictable errors (effect of barometric pressure, etc.) there is a definite outstanding fluctuation in SH4 (the clock particularly examined) which on one occasion exceeded 0·2 sec. and on three other occasions 0·1 sec. It is suggested that this error may be due to small variations in amplitude or that it may be of the character of an "escapement error"—that is, the impulse is not given exactly at the bottom of the swing. A. A. D.

653. Correction of the Effect of a Magnetic Field on the Going of Watches. P. Ditisheim. *Comptes Rendus*, 187. *pp.* 808–810, *Nov.* 5, 1928.

Two types of balance, provided with elinvar spirals, are described. These were fitted to movements mounted respectively in cases of German silver and in special cases constituting paramagnetic screens. For the latter certain alloys were used of high permeability, small hysteresis losses, and not readily oxidised. Careful tests were carried out on a number of watches thus protected from and corrected for the effect of magnetic fields. The tests were carried out both before and after placing the watches in a solenoid having an internal field of 22 gauss. The change of rate observed was very small for those watches provided with a magnetic screen, being of the order of one second, while one set of watches provided with elinvar spirals but with ordinary cases gained nearly three hours in one day under similar conditions. The combination of the elinvar spiral, special balance and magnetic screen thus gives a very marked improvement. A. W.

654. Airtight Spirit-Levels. A. de Gramont and G. Mabboux. *Comptes Rendus*, 187. *pp.* 885–886, *Nov.* 12, 1928.

In order to keep the diameter of the air bubble constant the two glass discs are sealed by a bakelite cement to a metal barrel with a similar coefficient of expansion. [See Abstract 2993 (1928).] T. M. L.

655. Further Experiments in Microbarometry. C. Barus. *Nat. Acad. Sci., Proc.* 14. *pp.* 771–773, *Oct.*, 1928.

The author has found that the error described in a previous paper [see Abstract 1 (1929)], due to the lag in the penetration of heat into the interior of the instrument, even when the variations do not exceed 0·1° C. per hour, can be largely overcome by enlarging the effective volume v of the air in the closed disc-like air volume above one pool of the U-gauge by connecting it with a Dewar flask. Details are given of the results obtained, which are a great improvement on the previous ones.

H. N. A.

656. General Physical Method for Reducing Partial Differential Equations to Ordinary Ones. G. Schweikert. *Zeits. f. Phys.* 51. 5–6. *pp.* 413–419, 1928.

From the expression for the total differential of the state function a simple relation between the partial differential quotients is obtained, with the help of the velocity of propagation and the law of absorption; and by means of this the partial differential equation is reduced to a system of ordinary ones. The method is illustrated, first by the simple case of a unidimensional spreading of an alteration of state $y(xt)$, which satisfies the differential equation $\lambda_1 \frac{\partial^2 y}{\partial x^2} - \lambda_2 \frac{\partial^2 y}{\partial t^2}$ of a vibrating cord. The problem of telegraphy is then dealt with, and the problems of transmission in isotropic and in non-isotropic media are treated.

H. N. A.

657. Slipping of Belts on Pulleys. R. Swyngedauw. *Comptes Rendus*, 187. *pp.* 805–808, *Nov.* 5, 1928.

Relations are derived between the various types of slipping which may be distinguished in power transmission by means of belts. **Erratum,** *ibid.* p. 964, Nov. 19, 1928.

A. W.

658. Period of a Loaded Conical Jolly Balance Spring. R. B. Abbott. *J.O.S.A. and R.S.I.* 17. *pp.* 318–322, *Oct.*, 1928.

An expression for the period of a conical Jolly balance spring is deduced theoretically, and the result is verified by experimental data. By some assumptions which simplify the equation of motion it is reduced to that for simple harmonic motion from which the period is obtained. The period is:—

$$\mathrm{T} = 2\pi\sqrt{\left(\mathrm{M} + \frac{m_0}{3\mathrm{K}}\right)\frac{h}{mg}}.$$

M is the mass of the load, m_0 is the mass of the spring, h is the extension of the spring for a load m and $c = (r_2/r_1 - 1)$,

$$\mathrm{K} = \frac{5[(c+1)^2+1]^2(c+2)^3}{(160 + 480c + 696c^2 + 620c^3 + 360c^4 + 135c^5 + 30c^6 + 3c^7)},$$

r_2 is the radius of the large end coil, r_1 is the radius of the small end coil. Very approximately, $\mathrm{K} = 1 + c/3$, so that

$$\frac{m_0}{3\mathrm{K}} = \frac{m_0}{2 + r_2/r_1}.$$

AUTHOR.

659. Change in Elastic Properties on Replacing the Potassium Atom of Rochelle Salt by the Ammonium Group. W. Mandell. *Roy. Soc., Proc.* 121. *pp.* 122–130, *Nov.* 1, 1928.

The elastic curves of sodium potassium tartrate [see Abstract 238 (1928)] and sodium ammonium tartrate exhibit considerable similarity, but the ammonium salt is the less elastic, as regards both twisting and stretching, and thus shows fairly uniformly increased deformation magnitudes. In conformity with the other changes in physical properties, such as size of space-lattices and interfacial angles, the elastic curves show small differences, especially in the directions where tensions or pressures give a maximum piezoelectric response. T. H. P.

660. Determination of the Piezoelectric Moduli of Sodium Ammonium Tartrate. W. Mandell. *Roy. Soc., Proc.* 121. *pp.* 130–140, *Nov.* 1, 1928.

Replacement of the potassium atom of Rochelle salt [see Abstract 238 (1928)] by the ammonium group causes a considerable change in the piezoelectric properties. For pressures in the direction bisecting the *bc* crystallographic axes, the polarisation along the *a* axis is decreased by about 95 %, whilst the other two values are only slightly diminished. The fact that the signs of the corresponding moduli for the two salts are the same is of interest owing to an intimate relationship existing between piezoelectric phenomena and optical rotation, for the ammonium salt has lævo- and the potassium salt dextro-rotation. T. H. P.

661. Visual Method for Studying Modes of Vibration of Quartz Plates. A. M. Skellett. *J.O.S.A. and R.S.I.* 17. *pp.* 308–317, *Oct.*, 1928.

A large number of beautiful patterns formed on the surface of a piezoelectric quartz plate by the glow discharge at low pressures of gas were observed at various radio frequencies of the exciting oscillator. They are caused by different modes of vibration of the plate, of which there seems to be a great number. Evidence in support of the theory that the bright spots in the pattern occur at the anti-nodes of standing waves in the plate is presented, from which it appears that the value of Young's modulus is the same for directions at angles of from 0° to 78° from the optic axis. These patterns explain the multitude of frequencies at which a piezoelectric quartz plate will vibrate observed by Cady and others. Water vapour was found to condense on the crystal in the configuration of the pattern corresponding to the last mode of vibration of the crystal, and a thin spark was produced about 13 mm. long between the electrodes and over the surface of the vibrating crystal at a pressure of 5 mm. AUTHOR.

662. Friction Constant and Surface Film. Part I. J. Traube and S.-H. Whang. *Zeits. f. phys. Chem.* 138. 1–2. *pp.* 102–122, *Oct.*, 1928.

The experiments are made with the simple viscosimeter of Traube and Magasanik, consisting of a capillary tube opening out at both the ends, which are bent over; the tube is clamped for variable inclination. When the tube is filled with an ether solution of oleic acid and the ether is allowed to evaporate, the glass wall becomes covered with a film of the acid; water then flows through the capillary at a much-increased rate (*e.g.*, four-fold). As the film wears off, the flow becomes slower again. Similar experiments with different materials disprove the sieve theory of membrance action of Traube, according to which the pores in colloidal membranes would form canals through which only molecules of smaller sizes can pass; the nature of the walls exerts an influence. Flow under pressure destroys the film. A distinction has to be made between polar substances insoluble in water (oleic acid) or soluble (octyl alcohol) on the one hand, and non-polar substances (paraffins and benzene) on the other; only the former accelerate the flow, but they do so even when solid (stearic acid, rubber). The phenomena depend upon the friction coefficient in accord with the theories of Poiseuille-Helmholtz and of Langmuir and Harkins, and they may explain the vitalistic movements of internal organs and resorption by differential friction. The swift movements of fishes are probably aided by their slimy bodies. Experiments on the effects of paints on aircraft are in progress. H. B.

663. Theoretical Considerations of the Traube-Whang Phenomenon. L. J. Weber and H. Neugebauer. *Zeits. f. phys. Chem.* 138. 3–4. *pp.* 161–168, *Nov.*, 1928.

As the reactive force between a polar substance like oleic acid and water is presumably much stronger than that between water and a non-polar substance, one should expect that the flow of water from a capillary, coated inside with a film of the acid, should be slower in the former case, and not more rapid, as Traube and Whang [see preceding Abstract] observe. But the acid molecules will orient themselves with regard to the water molecules, and the equipotential lines will be closer round their polar ends than with a less polar substance, whose influence extends less far away, so that the more removed molecules will, in the polar case, be less obstructed in their flow. The acid molecules may be adsorbed to the glass, but they will be able to oscillate and to collide with the water molecules. An adsorption layer can only be formed when the force between liquid and wall does not fall off too rapidly and at low rates of flow. The equations to be applied for the rates of flow are not those of Poiseuille, but the extended equations of Helmholtz. The considerations require a modification of Stokes' formula and are of importance for the capillary rise. H. B.

664. Validity of the Hagen-Poiseuille Rule for Vegetable Oils. P. Slansky and L. Köhler. *Kolloid Zeits.* 46. *pp.* 128–136, *Oct.*, 1928.

According to the rule of Hagen-Poiseuille, the rate of the discharge of a liquid from a capillary tube is proportional to the pressure on the liquid. Colloidal systems were supposed not to obey this rule, the rates of flow becoming too small at low values. Hess and Freundlich ascribed this to elastic properties of the sols, Wo. Ostwald to the internal structure of the sols. The authors determine the rates of flow of glycerin, gelatin solutions, and various oil (linseed, rapeseed, sesame, ground nut, olive, castor, etc.), both with a special viscosimeter designed for adjustable hydrostatic pressure and with an Ostwald-Kruyt viscosimeter. The deviations from the Hagen-Poiseuille rule were in all cases small, and castor oil, which is a good lubricant in spite of its high viscosity, did not behave abnormally. Drying vegetable oils would not appear to differ from other vegetable oils, and the oils examined may be regarded as diluted colloidal systems of weak structural viscosity. H. B.

665. Validity of the Hagen-Poiseuille Rule. Wo. Ostwald, V. Trakas and R. Köhler. *Kolloid Zeits.* 46. *pp.* 136–144, *Oct.*, 1928.

Comments on the paper by Slansky and Köhler [see preceding Abstract] based upon experiments made with an Ostwald-Auerbach overflow viscosimeter and the same materials, and also with mineral oils and mixtures of mineral and vegetable oils (voltol oils). Mineral oils do not indicate any structural viscosity at the usual rates of flow, nor do refined vegetable oils at ordinary room-temperature, but they do near 5° and 7°. Polymerised vegetable oils and voltol oils show it at ordinary temperature. The structural viscosity sets in already at relatively higher rates of flow when the capillary is wider. H. B.

666. Fluidity of Mercury. E. C. Bingham and T. R. Thompson. *Am. Chem. Soc., J.* 50. *pp.* 2878–2883, *Nov.*, 1928.

The suspicion that mercury exhibits slippage while flowing over unwet surfaces such as glass appears to be unfounded. The fluidity of mercury from 0° to 100° C. measured in a glass capillary viscometer was found to agree with earlier measurements. The rate of flow of mercury through a copper capillary is irregular, but decreases with time, particularly when the tube is well amalgamated. The values of the fluidity are quite untrustworthy. The effect is the indirect result of the slight solubility of copper in mercury. Differential solubility of the crystals causes large crystals to grow on the surface of the capillary, and these interfere with the flow. A. A. D.

667. Surface Energies of Crystals. W. D. Kusnezow, N. A. Bessonow and N. F. Pitschenin. *Zeits. f. Phys.* 52. 5–6. *pp.* 420–427, 1928.

A continuation of previous work [see Abstract 3039 (1927)]. Cleavage experiments on polycrystalline samples of NaCl, KCl and KI have completely established the theoretical assumptions previously given. Further tests were made on polycrystalline specimens of zinc, antimony and bismuth. The results obtained show that the cleavage method can be applied with certainty to determinations of the relative values of the surface energies of crystals of similar structure. A. W.

668. Relationship between Surface Tension and Heat of Vaporisation. H. Sirk. *Zeits. f. Phys.* 52. 1–2. *pp.* 21–26, 1928.

The relationship between u, the total energy of the surface per unit area, which can be calculated from the surface tension γ from the equation $u = \gamma - T\frac{d\gamma}{dT}$, the molecular volume at the boiling point (V) and the molecular internal heat of vaporisation Λ (measured in ergs) is deduced, utilising as the mean value of $L = 6\cdot06 \times 10^{23}$. The quantity L is given by Eucken from the equation of the thickness of a unimolecular layer in his work on the mole in that the mean molecular distance is given as $\sqrt[3]{\frac{V}{L}}$. It is shown that the quotient obtained by dividing the heat of vaporisation by the quantity $u \,.\, V^{2/3}$—*i.e.*, the so-called surface energy—is a constant. Walden determined the quotient from experimental data at normal boiling point. For 25 different materials Walden found the value to be 5·40 when the heat of vaporisation was measured in calories, but measured in ergs the value of the quotient becomes $\frac{\Lambda}{uV^{2/3}} = 2\cdot 26 \times 10^{8}$. In the present work it is shown that u can be identified with χ, *i.e.*, the statical part of the surface tension. Making this substitution, which is justified in the paper, the value of the quotient so obtained is $2\cdot 71 \times 10^{8}$. The divergence from the value obtained by Walden is explained on the ground of the approximate values used in the work. S. G. B.

669. Jaeger's Method as Applied to the Determination of the Surface Tension of Mercury. R. C. Brown. *Phil. Mag.* 6. *pp.* 1044–1055, *Nov.*, 1928.

From measurements of the surface tension of mercury by the bubble pressure method the values 472 and 477 dynes/cm. have been obtained for glass and platinum jets respectively at 18° C. Most of the difficulties recently encountered by Bircumshaw were also met with in the present investigation. Measurements of the pressure required to liberate the bubble, using glass tips with air, indicated that the bubble formed sometimes on the external, sometimes on the internal, circumference of the jet. With nitrogen much more consistent results were obtained, the bubble practically always forming on the external circumference. When the mercury was heated, certain glass jets always formed the bubble on the internal circumference even for temperatures lower than 100° C., although one was found which formed the bubble on its outer edge right up to 330° C. The mechanism of the formation of the bubble is discussed. L. L. B.

670. Some Integrals of the Differential Equation for Axially Symmetrical Flow in Tubes. T. Sexl. *Ann. d. Physik,* 87. 4. *pp.* 570–580, *Oct.* 12, 1928.

A systematic examination. The Poiseuille solution is the only possible state of steady flow, but several unsteady motions are found, including one with a series of ring vortices. The " quadratic terms " are neglected throughout. W. G. B.

671. Motion of an Ellipsoid of Revolution through a Frictionless Fluid under Gravity. S. Higuchi. *Tokohu Univ., Technol. Reports,* 7. 4. *pp.* 29–38, 1928. *In English.*

The problem is solved under the assumptions that the angular deviations are always small and that the motion of the ellipsoid is two-dimensional; the integral for the deviation from a straight line is not evaluated in finite terms, but a numerical evaluation is given. W. G. B.

672. Stability of a Kármán Vortex Street for Disturbances in Three Dimensions. K. Schlayer. *Zeits. f. angew. Math. u. Mechanik,* 8. *pp.* 352–372, *Oct.*, 1928.

As the result of a long mathematical discussion, in which certain plausible assumptions are made to determine the radius of the " core " of the vortices (a quantity which must be taken into account in dealing with three-dimensional disturbances), it is concluded that the Kármán conditions ensure " practical " stability. There also seems to be a small degree of instability, decreasing with the wave-length of the disturbance, but it is argued that this is without practical significance. W. G. B.

673. Variation of Velocity Amplitude close to the Surface of a Cylinder moving through a Viscous Fluid. N. A. V. Piercy and E. G. Richardson. *Phil. Mag.* 6. *pp.* 970–977, *Nov.*, 1928.

The suggestion that the discrete eddies in the wake of a body moving through a viscous fluid beyond the range of stream-line flow may be due to coalescence of neighbouring vortices during their passage over the surface of the body is further investigated. A quantity roughly proportional to the amplitude of the velocity fluctuation was observed at short intervals round twelve circles, concentric with the cylinder and separated from its surface by distances ranging from 0·0025 the cylinder diameter to one hundred times that amount. The readings taken allowed of the construction of contours, and the results, checked by an alternative method. A smooth aluminium cylinder, 4 in. in diameter, reaching from wall to wall of a 4-ft. wind channel, was used for the experiments. In the second set of measurements the periodicity is made audible by the employment of a hot wire and amplifying set. The results show that the turbulence in the region of the front stagnation point of a circular cylinder is not carried by the fluid round the surface. The velocity appears steady over about one-third of the surface facing the wind. Turbulence sets in afresh and rapidly increases to a maximum before the shoulder of the section is reached. A wedge-shaped funnel of high velocity almost touches the surface here, and this may possibly form the Levy exhaust dust for coalesced vortices. These vortices are collected from a small area on the neighbouring surfaces. Account of the mean velocity may be taken in subsequent experiments. S. G. B.

674. Fluid Motion in a Curved Channel. W. R. Dean. *Roy. Soc., Proc.* 121. *pp.* 402–420, *Nov.* 1, 1928.

Experiment has shown that the rise of resistance with increasing velocity in a curved pipe takes place more gradually and at lower Reynolds' number than in a straight pipe. In the present paper the disturbances in a steady flow under pressure between cylinders of radii a and $a + d$ (d/a small) are examined. The critical velocity is given by $\bar{v}d/\nu = 36(a/d)^{\frac{1}{2}}$, $\bar{v}$ being the mean velocity. The type of disturbance considered is similar to that investigated by G. I. Taylor for the motion between two rotating cylinders. It is also verified that for speeds less than the critical the disturbance is damped out. W. G. B.

675. Floating Needle Experiment. F. E. Beach. *Am. J. Sci.* 16. *pp.* 392–398, *Nov.*, 1928.

The scale of the experiments has been increased and a quantitative determination made of the factors which contribute to the support of the needle. The needle and water have a definite angle of contact, the value being almost the same whether steel or aluminium is used. Instead of the usual form of needle a tube of Al 6 mm. in diameter formed into a closed ring 6 cm. in outside diameter is used. This, when clean, floats easily. A small basket suspended from its lower side in the water contains added weights to drag the ring down. The ring is supported by (1) the buoyancy of the water displaced by the part of the body immersed, (2) the buoyancy of the water displaced from the space above the bared part of the ring, and (3) the outward components of surface tension. It is shown theoretically, and confirmed by experiments, that the sum of these three components equals the weight of the body. Since the upward pull of surface tension equals the weight of water filling the space between the depressed liquid surface and the undisturbed horizontal level, the weight of any floating body equals the total volume of liquid displaced by it below the upper horizontal level without regard to form of surface or surface tension. R. S. R.

676. Vortex Theory of the Screw Propeller. E. Hogner. *Ann. d. Physik*, 87. 3. *pp.* 385–423, *Oct.* 12, 1928.

Mathematical. The effects of the helical vortices assumed to be disengaged from elements of the propeller is considered, and the thrust, torque and losses are calculated. W. G. B.

677. Possible Influence of X-Rays on the Crystallisation of Bismuth. A. Rostagni. *Accad. Lincei, Atti*, 7. *pp.* 649–653, *April* 15, 1928.

It has been suggested that the irradiation of bismuth during solidification with X-rays, or with γ-rays, produces a lasting change in many of its properties, and similarly with some other metals. The author has made a careful examination of the properties of Bi irradiated during solidification and solidified under normal conditions, and concludes that there is no difference in the constitution of the two bodies examined.

J. J. S.

678. Crystal Structure of Some Rhombic Formates. I. Nitta. *Inst. Phys. and Chem. Research, Tokyo, Sci. Papers, No.* 162. *pp.* 151–163, *Sept.* 24, 1928.

Laue diagrams and spectrometric measurements of the formates of lead, barium, strontium, calcium and lithium give the following results:—

Formula.	Unit of Structure.				Space Group.	Specific Gravity.		Kinds of structurally non-equivalent Atoms.			
	No. of Mols.	*a.*	*b.*	*c.*		Actual.	Calculated.	Me	H	C	O
$PbFo_2$	4	6·52	8·75	7·41	V^4	4·63	4·64	1	2	2	4
$BaFo_2$	4	6·78	8·89	7·68	V^4	3·23	3·24	1	2	2	4
$SrFo_2$	4	6·86	8·72	7·24	V^4	2·69	2·71	1	2	2	4
$SrFo_2 . 2H_2O$	4	7·30	11·99	7·13	V^4	2·25	2·26	1	6	2	6
$CaFo_2$	8	10·16	13·38	6·26	V_h^{15}	2·02	2·02	1	2	2	4
$LiFo . H_2O$.	4	6·49	10·01	4·85	C_{2v}^9 or V_h^{16}	1·46	1·46	—			

The isomorphism of the formates of strontium, barium and lead is confirmed, the lattice being the simple orthorhombic, Γ_0. It is deemed quite probable that ionic lattices are formed. The space group V_h^{15}, assigned to calcium formate, differs from that V_h^5 arrived at by Yardley (*Min. Mag.* 20.296.1925), whose results otherwise agree. In the formates of all the divalent metals the two HCO_2 radicals are not structurally equivalent, as also is the case with the $2H_2O$ in strontium formate dihydrate. For lithium formate the space group C_{2v}^9 is deemed more probable than V_h^{16}. It was not found possible to determine atom coordinates, but general equivalent positions are given. In the case of strontium, barium and lead the structure of the formates is compared with that of the fluorides and nitrates. It was noted that though the solubility curve for strontium formate shows a transition point at 85°, anhydrous crystals were deposited at temperatures as low as 48°. C. A. S.

679. Crystal Structure of Potassium Sulphate. F. P. Goeder.

Nat. Acad. Sci., Proc. 14. *pp.* 766–771, *Oct.*, 1928.

The lattice constants of K_2SO_4 have been redetermined by the author by the powder method, $a_0 = 5\cdot771$ Å., $b_0 = 10\cdot064$ Å., $c_0 = 7\cdot518$ Å., with four molecules in the elementary cell, so that this contains eight K^+ ions and four SO_4^{--} ions, which if the SO_4 ions have a symmetrical structure can all be considered as a first approximation to be diffracting centres. Assuming a tetrahedral structure for SO_4, as used by Wasastjerna in the case of anhydrite, a number of possible arrangements become possible, one of which agrees best with the observational results. A figure is given which shows the probable arrangement of the atoms in the lattice, and a table gives the coordinates of the sixteen oxygen nuclei. The tetrahedral structure of SO_4 is in close agreement with that computed for $CaSO_4$. The agreement between the observed and calculated intensities in the powder photographs is good. H. N. A.

680. Stability of Submicrons. Solution of Crystals; Formation of Crystals and Emulsions. J. Traube and W. v. Behren.

Zeits. f. phys. Chem. 138. 1–2. *pp.* 85–101, *Oct.*, 1928.

When benzene or pentane are shaken with water the surface tension of the water is hardly changed, but physiological reactions and the Tyndall cone show that these chemicals are not insoluble. When there is little adhesion between the particles and the solvent—that is, when the a of van der Waals' equation is small—the particles in Brownian movements unite to complex submicrons [see Abstract 1865 (1922)], and these submicrons may be stable; they form the ultramicroscopic bricks of crystals and emulsions. It is shown that crystals of soluble inorganic and organic salts (complex cobalt compounds, etc.) surround themselves in pure water with layers and swarms of thousands of submicrons, whilst the farther field of the ultramicroscope is free of submicrons. This is not due to impurities, and the observations support Klein's assumption of a stability of submicrons. The dissolving crystal reveals its submicron structure, and conversely the formation of lead chloride crystals (crystallising from a solution of lead nitrate and sodium chloride) shows in the first instance the strings of beads of submicrons, which are again observed when the crystals dissolve. The addition of gelatin to the solution is not necessary to bring this out. When chloroform is added to aqueous saponin solution, the chloroform particles take up the hollows of beehive-cells while the submicrons are found in Brownian movement in the thin cell walls. As the chloroform evaporates it shows the Gibbs phenomenon, which Klein observed in the boundary, water-oil and water-air. The submicrons may remain in visible movement for twenty-four hours and more. The observations accord with Smekal's theory of crystal formation. H. B.

681. Structure of H_2O Molecule. R. Sänger and O. Steiger.

Helv. Phys. Acta, 1. 6. *pp.* 369–384, 1928. *In German.*

Calculates from the dielectric constants of water vapour that if the molecule of H_2O present the form of an isosceles triangle with the oxygen atom at its apex, the two equal angles of the triangle are 58° each, and the two equal sides are each $1\cdot07\cdot10^{-8}$. This gives an electric moment of $1\cdot34\cdot10^{-18}$. A. D.

682. Structure of Water. S. W. Pennycuick. *J. Phys. Chem.* 32. *pp.* 1681–1696, *Nov.*, 1928.

Like many other atoms, the oxygen atom exercises an active auxiliary valency in excess of the two formerly conceded to it and has a maximum coordination number 4. Similarly hydrogen has a coordination number 2, and water owes its unique properties to its auxiliary valency fields. In H-O-H, as in CH_4, the ten electrons (two closed neon shells) are arranged in four pairs at the corners of a tetrahedron and one pair in the interior. The two positive hydrogen nuclei are at two corners, so that the tetrahedron is unsymmetrical, and the molecule shows both positive and negative affinity in the formation of molecular compounds. In ice each oxygen atom is surrounded by four hydrogen atoms, which lie symmetrically between the oxygen atoms, and the whole structure is like that of the diamond [see Bragg, Abstract 1498 (1922)], the carbon atoms being in the hexagons replaced by oxygen with the hydrogens in between. The liquid water molecule is $(H_2O)_6$, and water is a mixture of relatively stable compound molecules of benzene ring structure in a quasi-associated solvent. The arguments are supported by reference to the effect of pressure on aqueous systems, on the addition of solvents, the maximum of density, high dielectric constant and latent heat, self-ionisation, and the high velocities of the ions $H^{\cdot}$ and OH'. The water ions are always hydrated, and it is impossible to say which of the removable hydrogen nuclei represent the hydrogen ion and which the hydroxyl ion. H. B.

683. Structure of Topaz. N. A. Alston and J. West. *Roy. Soc., Proc.* 121. *pp.* 358–367, *Nov.* 1, 1928.

The oxygen atom plays an important rôle in silicates, and its atoms may be closely packed throughout or only locally. Topaz $[Al\,.\,(F\,.\,OH)]_2SiO_4$ represents a variant of close packing. The structure depends chiefly upon the arrangement of the atoms of oxygen and fluorine, which are assumed to be of the same sizes, like their ions. The packing is neither hexagonal nor cubic, but consists of a series of identical planes closely stacked on the top of one another in periodic succession. This type of structure may also occur in the complex triclinic silicates; topaz is orthorhombic. H. B.

684. Structure of Cæsium and Ammonium Sulphates. W. Taylor and T. Boyer. *Manchester Phil. Soc., Mem.* 72. *pp.* 125–137, 1927–1928.

Photographic and ionisation methods have been used to show that the space-group of the isomorphous sulphates of cæsium and ammonium is V_h^{16}. The unit cells containing four molecules have dimensions:—

	a.	*b.*	*c.*
Cs_2SO_4	6·24	10·92	8·22
$(NH_4)_2SO_4$	5·98	10·62	7·78

From intensity measurements a structure has been given. [See also Ogg and Hopwood, Abstract 79 (1917) and *Nature*, 120. p. 498, 1927.] W. H. Ge.

685. Crystallisation of Mesomorphic Substances in a Magnetic Field. G. Foëx. *Comptes Rendus*, 187. *pp.* 822–823, *Nov.* 5, 1928.

A field of some thousand gauss acting on a nematic phase imposes on its molecules an orientation such that the substance takes the optical properties of a uni-axial with axis parallel to the field. The orientation can be shown by the measurement of the coefficient of magnetisation at different temperatures. The absolute value of this constant is notably smaller for the orientated nematic phase than for the solid or the isotropic liquid. When the orientated nematic phase crystallises without special precautions the coefficient of magnetisation increases sharply to a value near that which characterises the isotropic phase. The solid obtained, formed of little crystals orientated at random, is practically isotropic from the magnetic point of view. A strongly anisotropic solid is obtained in the following way: The substance is heated in the field till it is almost entirely melted; thus an orientated nematic phase is obtained in contact with a minimum quantity of solid. It is then allowed to cool to produce crystallisation; surfusion is avoided, and it is found that the coefficient of magnetisation remains rigorously invariable in the course of the solidification; it then retains the same value up to the ordinary temperature. The orientation of the molecules in the solid thus prepared is the same as in the orientated nematic phase. Details are given for azoxyanisolphenetol in its different states. The solid obtained in the field by crystallisation of the smectic phase was also investigated. J. J. S.

686. Structure of Heulandite Crystals. P. Gaubert. *Comptes Rendus*, 187. *pp.* 829–831, *Nov.* 5, 1928.

It is concluded that anomalies in the orientations of the plane of the optic axes and their inclination are due to foreign matter in the crystals. W. H. Ge.

687. X-Ray Study of Copper and Some Brasses. J. Loiseau. *Rev. de Mét.* 25. *pp.* 572–584, *Oct.*, 1928.

Application of X-ray methods to the study of favoured orientation in polycrystalline plates of copper and copper-lead alloys containing various amounts of lead subject to various heat treatments. W. H. Ge.

688. Crystal Structure of Mercury, Copper, and Copper Amalgam. H. Terrey and C. M. Wright. *Phil. Mag.* 6. *pp.* 1055–1069, *Nov.*, 1928.

Details are given of an apparatus for determining the crystal structure of mercury, cooled to − 150° C., by an X-ray method. The camera was constructed on somewhat similar lines to that used by McLennan and Wilhelm for their work on the crystal structure of solid carbon dioxide. Using Hull's plots, it was found that the diffraction given by mercury corresponded to a rhombohedral lattice (confirming McKeehan and Cioffi's work) with axial ratio 1·94 and $a = 2{\cdot}996$ Å. The value of the side of the unit copper cube, determined by the powder method, was found to be 3·603 Å., slightly lower than the precision value of Davey, 3·597 Å. Experiments were then made to determine the structure of copper amalgam, using a series of amalgams containing from 90 to 20 % of copper, and to see if any structural change occurs on the hardening of the amalgam. The results indicate that the amalgams, when first prepared, are merely mechanical mixtures of the two metals, but that, on hardening, a definite compound is formed containing 30–35 % copper. This compound is present all through the series of amalgams examined. The diffraction pattern does not accurately fit any of Hull's plots, the nearest agreement being for a simple tetragonal lattice with axial ratio 0·64. L. L. B.

689. Recrystallization in Aluminium Crystals. Part I. W. G. Burgers and J. C. M. Basart. *Zeits. f. Phys.* 51. 7–8. *pp.* 545–556, 1928.

A study by X-ray methods of the crystal orientation in single crystals of aluminium in which recrystallisation has taken place under slight deformation, consisting of a 10–15 % extension. W. H. GE.

690. X-Ray Determination of Crystal Orientation. S. Takeyama. *Kyoto Coll. Sci., Mem.* 11. *pp.* 469–479, *Nov.*, 1928.

A simple method for determining the orientation of crystal axes, especially convenient for a thick crystal, or a crystal grown on the surface of a thick substance, or for micro-crystals on the surface of metals which have been subjected to some regular cold working. In an ordinary rotating crystal spectrometer a V-shaped frame of lead wires is inserted between the crystal and the fixed photographic plate and is rotated with the crystal. The orientation of the axes is determined from the known wave-length of the monochromatic rays used, together with the positions on the spectral lines of the shadows cast by the lead wires. The method was applied to the study of the arrangement of the micro-crystals on the polished surface of copper, and it was found that most of the crystals were arranged with their (111) or (100) planes nearly parallel to the polished surface. W. H. GE.

691. Banded Structures in Metal Crystals. C. F. Elam. *Roy. Soc., Proc.* 21. *pp.* 237–247, *Nov.* 1, 1928.

Mainly by X-ray methods it has been shown that aluminium can form twins of the spinal type, as can also the structurally similar metals copper, silver and gold. The plane of composition can be the twin plane, but is not always so. Twins may be more common than appears, but may be overlooked because they do not show straight boundaries. Other types of twinning observed include " mechanical twins," discussed in the Appendix by **G. I. Taylor.** W. H. GE.

692. Change in Lattice Spacing at a Crystal Boundary. J. E. Lennard-Jones and Beryl M. Dent. *Roy. Soc., Proc.* 121. *pp.* 247–259, *Nov.* 1, 1928.

A theoretical paper showing that the contraction of the lattice at the (100) boundary of crystals of the NaCl type is of the order 5 % and is confined almost entirely to the top layer. An upper limit found for the decrease in the interatomic spacing in the surface layer is also of the order 5 %. The surface tension of a number of crystals of the NaCl type is calculated. The bearing of the results on electron diffraction by crystals is discussed. W. H. GE.

693. Lattice Constants of Gypsum. J. Nagy. *Zeits. f. Phys.* 51. 5–6. *pp.* 401–412, 1928.

The assumption is usually made that the distance between planes in the same crystal and in different crystals of the same substance is constant.

Recent researches [see Abstract 1176 (1920)] have shown that this assumption is only an approximation to the exact truth. The author's exact measurements with a Seemann spectrograph show that gypsum from different sources has measurably different lattice constants. J. E.

694. Grating Constants of CaO and $Ca(OH)_2$. E. Rumpf.

Ann. d. Physik, 87. 4. *pp*. 595–596, *Oct.* 12, 1928.

With the apparatus described before [see Abstract 250 (1928)] it is found that the grating constants of CaO and $Ca(OH)_2$ do not agree with the results of previous observers. The results are: CaO, $4 \cdot 799 \pm 0 \cdot 002$; CaOH, a $3 \cdot 582 \pm 0 \cdot 001$, c $4 \cdot 904 \pm 0 \cdot 008$. J. E.

695. Electric Moment and Structure of Diphenyl Derivatives. E. Bretscher.

Helv. Phys. Acta, 1. 5. *pp*. 355–361, 1928. *In German.*

Determinations of the respective dielectric constants of solutions of diphenyl and its *pp'*-dichlor, -dibrom, -difluor, -diamido and -dimethoxy derivatives in benzene show that whilst the atomic nuclei of the first four possess no electric moment, the last two are characterised by a considerable atomic electric moment. J. S. G. T.

696. Theory of Brownian Molecular Motion. R. Gans.

Ann. d. Physik, 86. 4. *pp*. 628–656, *July* 10, 1928.

Works out a partial differential equation for the probability of a given position of a Brownian particle, and shows how it can be applied to the molecular motion of bodies in general, such as the simultaneous translation and rotation of a triaxial ellipsoid, which includes the special cases of spheres, needles, and discs. E. E. F. D'A.

697. Evolution of the Odd-Numbered Elements. W. V. Howard.

J. Phys. Chem. 32. *pp*. 1725–1742, *Nov.*, 1928.

Plotting Aston's isotopes of even-numbered (e.n.) elements the author finds series of the types $M = 2N + 4X$, or $M = 2N + 4X + 2$, where M is the atomic weight or mass-number, N the atomic number and X an integer between 0 and 13. This holds also for odd-numbered (o.n.) elements, and it appears further that every e.n. element is preceded by an o.n. element whose isotopes have mass numbers which are less by one than one or both of the two lowest isotopes of the e.n. element. No o.n. element (above oxygen and below lead) has an even mass number, but several e.n. have o.n. isotopes. These relations are examined with reference to Aston, Harkins, F. W. Clarke, and A. S. Russell, and unknown isotopes are predicted. The first elements formed, from which all elements are derived, besides H and He, were probably the e.n. elements between Ni and C. Between C and Ca, M is equal 2N, or equal $2N + 2$, X being 0. This suggestion about the order of evolution is based upon the examination of meteorites and of B stars (containing He, H, Si, O, N) and A stars (Mg, Ca, Fe, Ti). After the formation of Ni, evolution proceeded in three ways: by the formation of higher e.n. elements, of o.n. elements, and of elements between N and Li. The addition of the nucleus cannot continue indefinitely unless more than two negative charges are added for every four positive, because the elements become unstable. In such cases neutrons are added, usually in pairs. The lower isotopes of any element are less stable than the higher ones. The o.n. elements were formed by disintegration of the e.n., one or both of the two lowest isotopes losing a positive charge and

one electron. These views are discussed with respect to the observations of Rutherford and Chadwick, that hydrogen atoms driven off from e.n. elements had shorter ranges than those from o.n. elements, to the transmutation experiment (Hg into Au, in which case the Hg isotope 198 breaks down into Au 197, and of Tl into Pb), to Perrin, to the association of the elements in the earth's crust, and to their heat of disintegration, which would explain the formation of magmas and the plantesimal hypothesis.
H. B.

698. Periodic System. Part I. Ionic Potential as a Periodic Function. Part II. Ionic Potential and Related Problems. G. H. Cartledge. *Am. Chem. Soc., J.* 50. *pp.* 2855–2872, *Nov.*, 1928.

The charge, structure and size of the ions are useful characteristic properties for the classification of the elements. The ionic potential ϕ is directly related to the ionisation potential for the removal of the last electron in the production of the ion, and $\sqrt{\phi}$ increases in approximately equal steps as the ionic charge increases without change of structure. The $\Delta\sqrt{\phi}$ becomes less as the principal quantum number of the outermost electrons in the ion increases. Thus the ϕ can be estimated, but this is difficult for hydrogen. The properties of the ion are definitely related to the structure of their outermost electronic shells, with particular respect to their completeness or incompleteness.

When a polar crystal is placed in water, the lattice is disrupted under the influence of the attraction between the ions and the polarised water molecules. According to Fajans, the heat of solution plus the lattice energy is equal to the sum of the heats of hydration of the ions. The heat of hydration of gaseous ions increases with ϕ. In the case of kations, an additional heat of evolution (overlooked in Born's formula) is caused by the effect of the outer electronic region of the ion in attracting the hydrogen ends of the water molecules. For salts with a common anion the heat of solution (evolution) increases with the ϕ of the kation, except for fluorides, in which this order is reversed. Kations of a $\sqrt{\phi}$ of less than 2·2 are basic, those between 2·22 and 3·2 are amphoteric, those above 3·2 are acidic in aqueous media. The electrolytic discharge potentials of fused electrolytes decrease with increasing ϕ. Kations having $\sqrt{\phi}$ greater than 2·2 form volatile chlorides which are non-conductors in the liquid state; as this value sinks below 2·2, the conductance increases rapidly, except in the case of the alkali ions, which vary in the reverse sense. Binary crystals increase in hardness as the ϕ of their constituents increase. H. B.

699. The Atom. E. Fermi. *Accad. Lincei, Atti*, 7. *pp.* 726–730, *May* 6, 1928.

Following up previous work [see Abstract 2597 (1928)] shows that it is possible to determine the energy of any given electronic orbit when its total and azimuthal quantic numbers are known, and calculates the Rydberg correction for the *s* terms for any value of Z. A. D.

700. Structure of Atoms. F. J. v. Wisniewski. *Phys. Zeits.* 29. *pp.* 716–721, *Oct.* 1, 1928.

In the proposed scheme there are a number of different structures for the atoms of each element; only one of the three L levels is present in each atom and only one of the five M levels. The following table shows the structure of the different atoms composing an element in which all the K, L and M levels are full:—

Ring Combination.	Number of Electrons in the Rings.								
	K	L_I	L_{II}	L_{III}	M_I	M_{II}	M_{III}	M_{IV}	M_V
K L_{II} M_{IV}	5		12					18	
K L_{III} M_{IV}	5			12				18	
K L_{III} M_V	5			12					21
K L_I M_{II}	5	9				13			
K L_I M_{III}	5	9					15		
K L_{II} M_I	5		12		?				
K L_{III} M_I	5			12	?				

The original paper should be consulted for a full explanation of the new theory. H. N. A.

701. Distribution Law in Rapidly Fluctuating Fields. B. Cassen. *Nat. Acad. Sci., Proc.* 14. *pp.* 763–766, *Oct.*, 1928.

Explains why Thomas and Fermi reach only roughly approximate results in determining the time average electrical potential round the nucleus of a heavy atom. The roughness is due to the unjustified use of the statistical distribution law of an ideal gas in a steady field in the case where the field is steady only when averaged over a sufficiently long time interval and is locally fluctuating. E. E. F. D'A.

702. Calculation of the Intermolecular Forces of Organic Compounds. M. Dunkel. *Zeits. f. phys. Chem.* 138. 1–2. *pp.* 42–54, *Oct.*, 1928.

A mathematical paper to show the additive character of intermolecular forces based upon considerations of the heat of vaporisation as deduced from the vapour-pressure curves. Strictly speaking, the heat of sublimation at absolute zero should be considered. The data are taken from hydrocarbons and simple alcohols. In the latter a constant increment in internal energy is observable, starting from butyl alcohol; the mol cohesion of these organic compounds seems to be the sum of increments. That would mean that the apparent mol cohesion should rise with increasing molecular weight, and that isomers of equal molecular weights built up of similar radicles could not essentially be different as to cohesion. When one of two such substances is volatile, and the other cannot be distilled, the latter should have a higher molecular weight. With increasing molecular weight the heat of vaporisation must finally become greater than the work to be done in separating a main valency. The probability of a decomposition would increase with increasing E/S and with increasing ϵ_{cr}, where E is the energy and ϵ_{cr} the critical energy of a molecule of S degrees of freedom, and beyond a certain limit distillation without decomposition would become impossible. H. B.

703. Collision of a Slow Electron with an Atom. K. Ochiai. *Phys. Math. Soc. Japan, Proc.* 10. *pp.* 120–126, *June*, 1928. *In English.*

The treatment by wave mechanics was discussed by Born and afterwards by Elsasser, who calculated the probability function, or working sectional area, for elastic and non-elastic collisions in the case of hydrogen to a first approximation. The angular distribution of the scattered particles is represented by a smooth curve, while experiment shows maxima and minima. The author has carried out the mathematical treatment to the second approximation. The probability of elastic collisions for very slow electrons tends towards $\pi A^2/4$, while Born's value was $4\pi A^2$. The formula for this probability, or working sectional area, seems to give a better explanation of the Ramsauer effect than that of Born, but the result for a very slow electron may not be correct. H. N. A.

704. Passage of Slow Electrons through the Inert Gases. F. v. Körösy. *Zeits. f. Phys.* 51. 5–6. *pp.* 420–428, 1928.

In explaining the Ramsauer curves for the section of action, the author assumes that electrons with velocities which are small compared with those of the electrons in the outer orbits of the atoms are only influenced by the molecules when they directly meet the outer electron shell; in other cases the molecule can be regarded as electrically uncharged as far as these outside electrons are concerned. When the above velocities are nearly equal the electrons may be strongly deflected, since their paths may nearly coincide with those of orbital electrons as they pass the atom, or may miss them, and the field of force of the molecule will extend beyond the surface. Still faster electrons will pass through the atoms with very small deflections, owing to their comparatively large momentum. The assumptions are supported by the following experimental facts: With slow electrons the collision and the action section are the same, as the theory requires. The maximum action section falls in the same order of magnitude of velocity as the velocity of the orbital electrons, and varies in the expected manner with the atomic number. The behaviour of certain gaseous compounds is plausibly explained on the same lines. The theories of F. Hund and W. Elsasser are briefly discussed. H. N. A.

705. Interpretation of Molecular Spectra. Part IV. F. Hund. *Zeits. f. Phys.* 51. 11–12. *pp.* 759–795, 1928.

Continues the work of previous papers [see Abstract 2810 (1927)], and enquires whether a more accurate description of the electron terms of a molecule is possible, which, as in the case of the atomic terms, will lead to a qualitative systematic arrangement of molecular spectra. The terms of a system with two nuclear centres are ascribed to definite electronic arrangements, and the terms belonging to each definite arrangement are defined. For different distances between the nuclei the arrangement of the single shells of electron varies, and the way in which this takes place as the nuclei approach one another is discussed. For the hydrides indications are found pointing to an interpretation of the empirical spectra; for other molecules the interpretation suggested is still quite arbitrary. Differences are found in the term schemes of molecules with equal, and those with unequal, nuclei. The alternations of intensity in N_2^+ are explained. The relations between the energy of ionisation and that of excitation are more complicated in the case of molecules than in that of atoms. Certain rules are found for the energy of dissociation. The separation of terms from one another produced when two atoms are thought of as uniting to form a single atom is studied. It is shown that the system of shells in a system with several centres shows a certain simplification as compared with a two-centre system. Some indications of an explanation of chemical combination appear, as in the valency idea of London, and the formation of chains in the cases of O, S, NH, CH_2. H. N. A.

706. Explanation of Certain Spectrum Properties by Means of the Quantum Mechanics of Rotating Electrons. J. v. Neumann and E. Wigner. *Zeits. f. Phys.* 51. 11–12. *pp.* 844–858, 1928.

In this mathematical paper the first approximations for the specific spinning functions are derived, starting from the solution of the spin-free differential equation for an atom, but with consideration of the degree of spin freedom of the electrons, *i.e.*, the Schrödinger equation, in which the magnetic moments of the electrons are not introduced. From the data obtained, the authors derive the Landé *g*-formula, the Burger-Dorgelo summation propositions, etc. [See Abstracts **2663** (1927) and **1260** and 2372 (1928).] H. H. Ho.

707. Structure of the Diatomic Molecular Spectra according to Quantum Mechanics. E. Wigner and E. E. Witmer. *Zeits. f. Phys.* 51. 11–12. *pp.* 859–886, 1928.

The structure of molecular spectra is theoretically investigated in this paper by the aid of the group method. Previous work is discussed [see Abstract 2826 (1927)]. The first part of the paper (§§ 1–9), after derivation of the first approximations of the specific functions, deals with the choice and intensity rules and the structure law of a rotation band. In the second part (§§ 10–15) the structure law of the electronic terms of the molecule is given, which is assumed to arise by the association of two atoms. H. H. Ho.

708. Spinning Electrons. L. Brillouin. *Nat. Acad. Sci., Proc.* 14. *pp.* 755–763, *Oct.*, 1928.

In order to interpret the multiplet structure of the line spectra it was supposed that the electron is not merely an electric charge, but that it has a spin angular momentum and a magnetic moment (equal to one Bohr magneton). When there is a magnetic field acting upon the electron, the axis of rotation must lie in the direction of the field. This gives two different orientations according to the magnetic moment having the same direction as the field, or the opposite direction. For each quantised orbit of the electron we shall get two different energy levels corresponding to these two different orientations; this is the explanation of the well-known sodium doublet, for instance. The author suggests an experiment to test this hypothesis, involving the projection of a beam of electrons into a weak magnetic field and their attraction by an electrode inserted in the pole of an electromagnet. E. E. F. d'A.

709. Group Theory of the Reciprocal Action of Atoms. W. Heitler. *Zeits. f. Phys.* 51. 11–12. *pp.* 805–816, 1928.

Investigates the reciprocal action of any number of atoms with a view to obtaining a theory of chemical composition in the case of molecules with several atoms. The theory of homopolar chemical combination has so far only been developed for molecules with two atoms; for those of the type NH_3, CH_4, etc., where a central atom is surrounded by other atoms, the existing theory may also be applicable. The author investigates the reciprocal action between any number of atoms each having one or more photoelectrons, using existing mathematical data and methods and calling particular attention to a work by Delbrück dealing with closed shells by the perturbation method, using the group theory. This leads to the reciprocal action of a number of mechanical systems included in a certain symmetrical term system. Chemical problems, however, are concerned with the reciprocal action of atoms included in an anti-symmetrical term system, and this is the case which is dealt with mathematically by the author, who obtains an expression for a number of different energies of reciprocal action of a number of anti-symmetrical atoms, which all belong to the same term system. The result agrees with that obtained by London for the case of two atoms. Examples are given of the application of the theory. H. N. A.

710. Molecular Association in Binary Liquid Mixtures. J. Errera. *Comptes Rendus*, 187. *pp*. 727–730, *Oct*. 22, 1928.

The curves of vapour tension of binary liquid mixtures of various concentrations are considered and the cases discussed in which neither, one only, or both of the molecules present are polarised. It is concluded that if the curve be concave, both components must be polarised or partially ionised. If not more than one component be polar, the curve is a straight line or else is convex. F. S.

711. Diffusion of Metastable Atoms in Mercury Vapour. J. H. Coulliette. *Phys. Rev.* 32. *pp*. 636–648, *Oct*., 1928.

Mercury vapour was contained in a four-electrode tube of special construction, with short voltage-pulses actuating the accelerating and photoelectric gauzes, separated by variable time-intervals. The change in the rate of arrival of metastable atoms at the outer boundary of a spherical volume of gas was determined as a function of the time elapsed after a number of atoms had been formed at the centre. The pressures varied from 3×10^{-9} mm. to 0·33 mm. A comparison of the experimental with the theoretical results for normal mercury atoms under the same conditions shows that the assumptions made by Webb and Messenger that metastable atoms travel across the experimental tube and produce a direct action upon the photoelectric plate are correct. The metastable mercury atom has an effective radius 1·5 times that of the normal atom; both obey the same diffusion laws. There was evidence of loss of energy of excitation as the result of collision between normal and metastable atoms. A. C. M.

712. Magnetism and Nuclear Structure. D. Enskog. *Zeits. f. Phys.* 52. 3–4. *pp*. 203–220, 1928.

Calls attention to a small error in the author's previous paper on the Bohr magneton and radioactivity [see Abstract 950 (1928)]. This is allowed for, and a more recent value of the observed energy of disintegration is made use of. In this way the agreement with the author's theory is considerably improved. Calculations are also made dealing with the building up of a nucleus by additions of protons. The added proton considered is supposed to revolve round a magnetic nucleus. On the assumptions made it appears that the resulting calculated packing defects are of the right order. H. N. A.

713. Experimental Method for the Measurement of Molecular Rays. H. Mayer. *Zeits. f. Phys.* 52. 3–4. *pp*. 235–248, 1928.

The resultant force on a small vane, due to impinging molecular rays, was measured by mounting the vane on one arm of a torsion balance and determining the rotational displacement of the arm from the no-force position. The system investigated consisted of two chambers containing gas at very low and slightly different pressures, the wall separating the high- and low-pressures regions being pierced with a small hole so that a steady stream of molecular rays radiated from the aperture into the low-pressure chamber. The test vane system was mounted at different positions in this stream and the deflection observed. The method was applied to obtain (*a*) a confirmation of Knudsen's laws for the streaming of low-pressure gases through narrow openings, and (*b*) a direct experimental proof of the so-called cosine law for molecular radiation. W. S. S.

714. Schrödinger Dynamics. A. Bramley. *Frank. Inst., J.* 206. *pp*. 605–621, *Nov.*, 1928.

This paper contains a concise description of the Schrödinger theory, which is based on the hypothesis that the fundamental properties of the electron can be derived from the solutions of the wave equation $\nabla^2\psi - \frac{1}{u^2}\frac{\partial^2\psi}{\partial t^2} = 0$, with $u^2 = E^2/2m(E - V)$, where V is the potential energy function, *m* the mass of the electron, and E a characteristic constant whose value represents the total amount of energy the atomic system has available for radiation. The author first discusses the wave equations which specify the motion of the electron and quantum respectively, treating them as special cases of the general wave equation, and then derives the equations of motion. Following this comes a consideration of the type of motion of the electron and light quantum respectively in a few simple cases which are of particular interest. The hydrogen atom is treated at length because it leads to interesting results concerning the orbit of the electron and the wave-length of the ψ-waves associated with its motion. H. H. Ho.

715. Spherical Electrified Particles and the Bohr-Sommerfeld Orbits. L. Décombe. *Comptes Rendus*, 187. *pp*. 823–826, *Nov*. 5, 1928.

A discussion of the undulatory conditions satisfied by the privileged orbits of Bohr-Sommerfeld. Amongst other conclusions, the author considers that if it is supposed that the electronic particle is susceptible of other pulsations than the fundamental one, then the variation experienced by the frequency of the *p*th harmonic of the electronic pulsation when an electron at first free and at rest passes towards the orbit of order *p* is equal for an element of atomic number A to the constant quantity RA^2. This gives a simple physical meaning to Rydberg's constant R. The author considers his results safeguard the undulatory point of view and extend it in a simple and concrete physical form into a domain occupied with apparent success by emission theories. J. J. S.

716. Principle of Uncertainty in Weyl's System. G. Breit. *Phys. Rev*. 32. *pp*. 570–579, *Oct*., 1928.

In Weyl's formulation [see Abstract 840 (1928)], if a ray is not directed in the direction of the principal axis of the quadratic form corresponding to a given physical quantity, no certain measurement of the latter is possible. This is essentially the principle of uncertainty. The present work aims at deriving explicitly the uncertainty for the momentum if the coordinate is known with a certain precision, using the Weyl theory.

It appears that in the discrete representation, for a definite axis of the coordinate q all eigenwerte of the conjugate momentum p are equally probable. The results in the limit of a very dense eigenwerte spectrum are essentially the same as obtained by the methods of Heisenberg or Bohr. W. S. S.

717. New Signification for the Wave Equation of Matter. T. Takeuchi. *Zeits. f. Phys.* 51. 11–12. *pp.* 887–888, 1928.

Attention is drawn to an analogy between the Schrödinger wave equation for the force-free motion of mass points in space and the equation for the " distribution function " occurring in the theory of Brownian motion. W. S. S.

718. Kinetic Theory of Gravitation. Part IV. Correlation of Continual Generation of Heat in Some Substances and Impairment of their Gravitational Acceleration. C. F. Brush. *Am. Phil. Soc., Proc.* 67. 2. *pp.* 105–117, 1928.

The author reviews his work relating to the continual generation of heat in certain silicates [see Abstract 2924 (1928)], and briefly describes an extension of the work designed to obtain data enabling the results to be correlated with the diminished gravitational acceleration experienced by these silicates when falling under gravity. J. S. G. T.

719. Accuracy Attained in the More Recent Repetitions of the Michelson Experiment. A. Piccard and E. Stahel. *Helv. Phys. Acta*, 1. 5. *pp.* 362–368, 1928. *In German.*

The repetitions of the Michelson experiment on ether drift by Miller, Kennedy, Ellingworth and the present authors are critically reviewed [see Abstracts 60 (1927) and 1518 (1928)]. Miller's positive result indicating a definite ether drift is possibly attributable to a " psychological " error. J. S. G. T.

720. New Experiment relating to Ether Drift. A. Dworsky. *Zeits. f. Phys.* 52. 1–2. *pp.* 141–144, 1928.

Objections to the interpretation of the Michelson and similar experiments on ether drift, involving reflection, are briefly discussed, and an experiment is suggested in which the path traced by a light ray incident upon a screen at some distance from the source should be either a circle or a straight line according as the ray is propagated respectively at right angles or parallel to the plane of the earth's orbit. J. S. G. T.

721. Einstein Cosmological Term. T. Takeuchi. *Tohoku Math. J.* 30. *pp.* 55–57, 1928. *In English.*

The cosmological term, λ, in Einstein's world is shown to be a negative pressure. J. S. G. T.

722. Refraction of Material Waves from the Standpoint of the Special Theory of Relativity. H. Bauer. *Zeits. f. Phys.* 52. 3–4. *pp.* 221–224, 1928.

The refraction of a de Broglie train of waves passing from a vacuum into a refracting medium is discussed, and an expression for the refractive index, n, of the medium deduced in the form

$$n = \{1 - 2V(1 - V/2W)/mv^2\}^{1/2},$$

where $\overline{V}$ denotes the potential energy of the medium, W the total energy of the particles concerned in the production of the waves, m the mass of the particles, and v their velocity. As a first approximation, the Newtonian formula is deduced from this expression. J. S. G. T.

723. Field of a Charged Thick Spherical Shell on Einstein's Theory of Relativity. T. Takeuchi. *Tohoku Math. J.* 30. *pp.* 51–53, *Sept.*, 1928. *In English.*

The gravitational field within a spherical electrically or materially charged body is discussed. Within the electrically charged body Gauss's theorum is shown to be valid, whilst in the cavity of a material shell the metric is Euclidean. J. S. G. T.

724. Relativistic Generalisation of Einstein's New Theory. T. de Donder. *Comptes Rendus*, 187. *pp.* 817–819, *Nov.* 5, 1928.

Einstein's results [see Abstract 70 (1929)] are shown to be particular cases of the theory here developed. The electromagnetic potential is derived in the form $\phi_a = \Lambda^{\beta}_{a\beta}$ or $h^{\beta a}(h_{aa,\,\beta} - h_{\beta a,\,a})/2$. J. S. G. T.

METEOROLOGY AND GEOPHYSICS.

725. Noctilucent Clouds and Unpublished Measurements of their Velocity. F. S. Archenhold. *Monthly Weather Rev.* 56. *pp.* 278–280, *July*, 1928.

The author reproduces extracts from an unpublished paper by O. Jesse summarising observations on noctilucent clouds in the years subsequent to the Krakatoa eruption of 1885. Photographic measurements gave a movement mainly from N.N.E., but the direction varied for different days, and was from a more easterly point after midnight than before. Mostly the direction was from 48° before midnight and from 63° after midnight, with a secondary maximum from 287°. The mean speeds were 31 m/s for west and 67 m/s for east azimuth, but the range gave 25–200 m/s after and 0–85 m/s before midnight. The author discusses the retardation of the earth's atmosphere at these high levels as evidenced by the cloud movements and effects probably produced by Halley's comet in 1910, when similar clouds were seen. R. S. R.

726. Methods and Results of Definitive Air-Pressure Measurements. H. Koschmieder. *Monthly Weather Rev.* 56. *pp.* 305–310, *Aug.*, 1928.

The author gives details regarding measurements made on the Schneekoppe to determine the corrections to be applied to the pressure on account of (1) orographic effects (mountain ranges, etc.); (2) effects caused by the building; and (3) effects due to the pressure measuring or pressure decrease apparatus. The building effect depends on wind direction and speed and on certain weather conditions. After elimination of this effect, the orographic effect was determined for different wind speeds and directions. The results obtained are shown graphically. R. S. R.

727. Modification of the Strophic Balance for Changing Pressure Distribution and its Effect on Rainfall. D. Brunt and C. K. M. Douglas. *Roy. Meteorolog. Soc., Mem.* 3. *pp.* 29–51, *Sept.*, 1928.

An equation is obtained in which the effects of changing pressure distribution, curvature of the air path, and acceleration of the air are shown separately. Reasons are put forward showing that in certain cases the effect of the changing pressure is larger than the other two terms mentioned, so that an estimate of the deviation of the wind from the geostrophic wind can be derived from an isallobaric chart. This chart should, for accuracy, be based on instantaneous changes of pressure. The occurrence of rain in isallobaric lows, and of fine weather in isallobaric highs, is attributed to the effects of convergence or divergence over these regions of the deviations from geostrophic wind. Similar arguments hold for rainfall at fronts. Examples are given supporting these views, and showing also that the motion of the front itself may differ from the motion computed from consideration of geostrophic wind alone. Direct measurements of the changes of pressure, and also deductions from rates of rainfall and the movements of the fronts, indicate that deviations from gradient winds at the 600-m. level ranging up to 5 m/s are quite common, while in extreme cases the figure may be appreciably greater. It is shown that a convergence of 5 m/s over a circle of radius 200 km. will give rain of about 4 mm./hr., to be classed as heavy rain. In Appendix I it is shown that friction can in general produce only light rain, or at most a narrow band of heavier rain along a cold front with very light rain behind it. In Appendix II the effect of turbulence in a smoothed sloping surface of discontinuity is shown to cause convergence in the lower layers. R. S. R.

728. Evaporation from Large Bodies of Water and Some Figures for Chesapeake Bay. R. C. Wells. *Washington Acad. Sci., J.* 18. *pp.* 461–468, *Oct.* 19, 1928.

The author discusses the results obtained by Bigelow from measurements of the vapour pressure at heights between 0 and 45 ft. above the level of the Reno reservoir, Nevada. A vapour pressure-height gradient is found, and the evaporation calculated for various wind speeds. Constants have been obtained from Dalton's equation for evaporation, to be used for large bodies of water when humidity, temperature and speed of the wind at 1 or 2 ft. can be obtained or calculated from available data. The results are applied to find the annual evaporation from Chesapeake Bay from available data for Baltimore and Norfolk. This gives a value almost equal to the annual precipitation. R. S. R.

729. Old Meteorological Observations in Bergen. Pressure and Temperature for 100 Years. B. J. Birkeland. *Geofysiske Publ. Oslo,* 5. *No.* 8. [56 *pp.*], 1928. *In German.*

To a broken series of observations for Bergen values have been added for neighbouring stations to form a complete series for the period 1816–1926. The individual sets of observations are discussed. In tables are expressed for both temperature and pressure at Oslo: (1) mean monthly and annual values for each year 1816–1914; (2) 5-, 25- and 100-yearly means; (3) monthly maximum and minimum values for 1818–26 and 1848–1926; (4) monthly oscillations of pressure for 1818–26 and 1848–1926; (5) climatic summary for the 100 years; and (6) deviations from the 100-year means for the individual month. For Fredriksberg the same series of tables is given, but extending over a considerably shorter period. R. S. R.

730. Variations of Solar Radiation. C. G. Abbot. *Terr. Mag.* 33. *pp.* 149–150, *Sept.*, 1928. *Paper read before the Am. Geophys. Union, Washington, April,* 1928.

The author discusses the measurements of the solar constant obtained in America and the corrections applied for variations of atmospheric humidity. The influence of ozone upon the results at Mt. Montezuma is found to be negligible, but a correction is necessary for its variation at Table Mountain, California. With these corrections, the North and South American stations agree in showing a change of several per cent. through the sunspot cycle, with 2 to 3 % higher values at sunspot maximum, while periodicities of 25⅔, 15 and 11 months are shown for observations extending over the last six to eight years. R. S. R.

731. Ozone in the Northern and Southern Hemispheres. F. E. Fowle. *Terr. Mag.* 33. *pp.* 151–157, *Sept.*, 1928. *Paper read before the Am. Geophys. Union, Washington, April,* 1928.

The author considers that asymmetry of atmospheric conditions exists in the northern and southern hemispheres according to measurements of the solar constant. Curves show the values obtained for the ozone absorption, plotting atmospheric transmission coefficients against spectrum deviations, whilst daily and monthly values for Table Mountain and Mt. Montezuma are also shown. These show maximum absorption early in the year and a minimum in November. The amount of ozone above Table Mountain shows a relationship with the magnetic character of the day, the total spottedness of the sun, and especially with the number of flocculi over the whole disc. [See also Abstract 2003 (1927).] R. S. R.

732. Meteoric Procession of Feb. 9, 1913. W. J. Fisher. *Popular Astron.* 36. *pp.* 398–403, *Aug.–Sept.*, 1928. *Harvard Reprint No.* 47.

The author discusses the data collected by Chant, and the conclusions drawn regarding the path, speed and height of the meteors. He abandons the idea of simplicity for the phenomena and takes account of the spheroidal shape of the earth and diurnal rotation. He concludes that the objects seen in Saskatchewan were partly destroyed in the atmosphere and partly entangled in the lower atmosphere and sank in the Atlantic. The objects seen near the equator were originally higher members of the stream of meteors, some of which may have escaped the equatorial bulge and got away again. R. S. R.

733. Temperature Retardation of Meteorites as a Source of Error in the Calculation of the Pressure of the Highest Layers of the Atmosphere. W. Anderson. *Phys. Zeits.* 29. *pp.* 721–724, *Oct.* 15, 1928.

The author criticises the results obtained by Sparrow [see Abstract 1534 (1926)] on the ground that when obtaining his results he neglected the energy required to raise the temperature of the meteorite. With this correction, calculations are made for the pressure of the air layer penetrated for successive increases of temperature of 100° C. While Sparrow's results are reasonably accurate for a meteorite infinitely small, considerable errors arise when the mass is increased, particularly for a vertical descent through the air. The error is still larger if, instead of hydrogen in the outermost layers, nitrogen is present. R. S. R.

734. Detonating Meteor of 1926, September 6. An Instance of an Outer Zone of Audibility. F. J. W. Whipple. *Roy. Astron. Soc., M.N. Geophys. Suppt.* 2. *pp.* 89–96, *Oct.*, 1928.

The evidence for a zone of silence deducible from the reports of sounds due to the detonating meteor that burst over South Yorkshire on September 6, 1926, is considered. The places reporting such sounds are indicated on a map, and show an outer zone of audibility extending in a curve from Oswestry to Woodstock (115–165 km. from the origin of the sound), with a possible extension to Rumburgh in Suffolk (226 km.)—the variation in distance is attributed to wind—and separated from the central area of audibility by a zone of silence some 60 km. in breadth. The theoretical position of such a zone is worked out on the assumption that the temperature of the atmosphere decreases from 290° (abs.) at ground-level to 210° at 12 km., remains constant to 32 km., and then increases at the rate of 6·06° per km. In the present case the distance to Leominster (about the centre of the outer zone observed) corresponds to a height for the source of about 40 km.—the height deemed most probable from other considerations, thus rendering the assumed distribution of temperature probable. C. A. S.

735. Figure of the Earth. W. Werenskiold. *Geofysiske Publ. Oslo,* 5. *No.* 7. [9 *pp.*], 1928. *In English.*

The author considers the principal ellipsoid as that having the same axis as the earth's ellipsoid, and then determines the corrections to be applied to the constants of the principal ellipsoid to get for each latitude an ellipsoid of reference, or osculating ellipsoid, with the same radius of curvature as the spheroid. The tabulated results show the greatest corrections to the radius of curvature of the meridian at the poles and equator, and zero at the arctic and tropic circles. At latitude 45° the maximum negative correction is found. The radius of curvature of section perpendicular to the meridian is little different from that belonging to the ellipsoid from the equator to middle latitudes, but at the poles the correction is the same for both radii of curvature. The dimensions of the ellipsoid fitting best for the latitude of Oslo, 60°, are given. R. S. R.

736. Ellipticity of the Earth's [Gravimetric] Equator. M. Bossolasco. *Comptes Rendus,* 187. *pp.* 814–817, *Nov.* 5, 1928.

The author contends that the minor axis of the earth's gravimetric equator extends in a direction 3° 55′ east of Greenwich, and that the difference between the major and minor axes of the equatorial gravimetric ellipse is 340 metres. J. S. G. T.

737. Relation of the Magnetic Work of the United States Coast and Geodetic Survey to Geophysical Methods. D. L. Hazard. *Terr. Mag.* 33. *pp.* 129–134, *Sept.*, 1928. *Paper read before the Am. Geophys. Union, Washington, April,* 1928.

The magnetic survey of the U.S.A. gives results for 5000 stations, and for a limited number the observations are repeated at five-yearly intervals. The results indicate regions where a detailed survey may give fruitful information. The author discusses the diurnal and seasonal variation of the magnetic elements and magnetic storms, and the necessity for a knowledge of these when conducting a magnetic survey. To obtain an accuracy of 1 in 1000, a temporary observatory should be maintained near the field of operations, making observations in it coincident with those in the field. Corrections can thus be applied for changes in the earth's magnetism. R. S. R.

738. Geophysical Methods of Prospecting, with Special Reference to Magnetic, Radioactive and Electric Methods. C. A. Heiland. *Terr. Mag.* 33. *pp.* 135–140, *Sept.*, 1928. *Abstract of Paper read before the Am. Geophys. Union, April,* 1928.

The author divided these methods into two classes: (1) those in which the direct effects of subterranean inhomogeneities are observed (gravitational methods); and (2) those in which artificial fields of force are produced and their distortion by subterranean bodies of different physical properties is measured (seismic, magnetic, electric and radioactive methods). In tabular form is summarised for each method the measurements made, apparatus used, subject of measurements, physical effect of disturbance, and the applications of the method. In rather more detail the magnetic, radioactive and electric methods are discussed. R. S. R.

739. Geophysical Prospecting: Some Electrical Methods. A. S. Eve and D. A. Keys. *Dept. of Commerce, Bureau of Mines, Techn. Paper No.* 434. [41 *pp.*], 1928.

The author describes the results obtained by ten different methods, three magnetic and seven electrical, on a survey of a known piece of ground. The most effective methods used were: (1) Measurements of equipotential surfaces in the field between parallel wires excited by (*a*) direct and (*b*) alternating current; (2) magnetic field directions found by a search coil with amplifier and telephone receiver; (3) direction of the natural currents found by suitable electrodes and a micro-ammeter; and (4) the leapfrog method, in which the conductivity of the soil is found step by step. The most suitable method depends upon the nature of the soil, its dryness, etc. The electrical and magnetic methods agree very satisfactorily in locating ore bodies, but some results are more easily interpreted than others. It was found that radio waves can be received at depths exceeding 500 ft. The lines have been indicated along which further tests are required. R. S. R.

740. Electrical Prospecting. J. J. Jakosky. *I.R.E., Proc.* 16. *pp.* 1305–1355, *Oct.*, 1928.

The author describes fully the principles of the methods employed, the outfit used, and the results of a number of tests. With four men as crew, work at a rate of 8–25 acres per day, depending upon topographic conditions and the amount and type of mineralisation present, can be done in locating the plan of mineralised zones and their approximate depth and width. The results should be examined in connection with the geology and known ore occurrence of the district. Proper cooperation is needed between geophysicists, mining engineers and geologists to interpret all available data. R. S. R.

741. Transmission of Elastic Waves through Surface Rocks. R. W. Goranson. *Terr. Mag.* 33. *pp.* 143–148, *Sept.*, 1928. *Paper read before the Am. Geophys. Union, Washington, April,* 1928.

On the analogy of the method whereby the sub-surface structure of the earth is deduced from time-distance curves for elastic waves derived from seismological observations, a method of inferring the probable presence of a salt dome (so important in oil geology) is based on the fact that the velocity of longitudinal waves in average sediments is about 2 km./sec., while in rock-salt it is 4·4 km./sec. It is shown that if there is a salt dome at a depth of about 200 m., the longitudinal wave produced by an artificial shock will reach a point distant 1 km. therefrom when travelling *via* the salt about 1/10 sec. before a similar wave travelling through the surface sediments. C. A. S.

742. Effect on Love Waves of Heterogeneity in the Lower Layer. H. Jeffreys. *Roy. Astron. Soc., M.N. Geophys. Suppt.* 2. *pp.* 101–111, *Oct.*, 1928.

The wave- and group-velocities of Love waves have been calculated for two systems: (*a*) with an upper layer 15 km. thick; (*b*) with one 30 km. thick, underlain by a heterogeneous layer such that the velocity of distortional waves therein increases uniformly until it becomes double at 2400 km. This heterogeneity increases the wave-velocity at all periods, is insignificant for periods less than five times that taken by a distortional wave to traverse the upper layer (T/β), but becomes considerable for longer periods. Group-velocity is diminished, insignificantly for periods less than $8T/\beta$, never largely, and for long periods apparently approaches the velocity of distortional waves near the top of the upper layer. The assumption of heterogeneity in the lower layer has little effect on the estimate for the thickness of the upper layer deduced from the dispersion of Love waves of periods not more than 50 sec., but for waves of period 60 sec. and upwards, observed values for group-velocity exceed theoretical by about 0·2 km./sec. This may be due to abnormal dispersion in the neighbourhood of a maximum group-velocity. The discrepancy does not appear to be removed to more than a slight extent by assuming an intermediate layer of crust, as done by Stoneley and Tillotson [see Abstract 2294 (1928)]. C. A. S.

743. Persistence of the 21-Minute Period during the Nine Years 1918–1926, as shown by the Philippine Records of Earthquakes. H. H. Turner. *Roy. Astron. Soc., M.N. Geophys. Suppt.* 2. *pp.* 73–76, *Oct.*, 1928.

The periodicity of approximately 21 min. in the recurrence of earthquakes previously noted [Abstract 2287 (1928)] and its possible dependence on the latitude are further examined by analysis of lists of shocks in the Philippines during the years 1918–26, as providing a series of observations roughly constant in latitude. A periodicity of 20·993342 min. is found to persist throughout the nine years, characterised by a sharp rise in frequency followed by a steady fall. It is considered that this persistence can scarcely be peculiar to this special neighbourhood, and that, therefore, it may reasonably be expected that the whole earth is affected in some persistent way. C. A. S.

744. Frequency of Microseisms of Different Periods at Eskdalemuir and at Kew. F. J. W. Whipple and F. J. Scrase. *Roy. Astron. Soc., M.N. Geophys. Suppt.* 2. *pp.* 76–88, *Oct.*, 1928.

The possibility of microseisms of certain periods occurring predominantly and of others being absent, suggested as a result of his examination of the Barcelona records by Castrillon (Institut d'Estudis Catalans, Seccio de Ciencies, Mem., 1, f. 1, 1927), has been tested by examination of such records at Kew and Eskdalemuir. It is concluded that such predominance and absence are probably due merely to some tendency on the part of the tabulator to give preference to certain periods. Full details of the methods used are given. There appears to be a regular diurnal variation in both amplitude and period of the microseisms at Kew, the disturbance being greatest at night. C. A. S.

745. Probable Epicentre of the St. Lawrence Earthquake of Feb. 5, 1663. E. A. Hodgson. *Roy. Astron. Soc. Canada, J.* 22. *pp.* 325–334, *Oct.*, 1928.

The author finds that severe earthquakes occur at sixty-year intervals in the St. Lawrence valley, mostly with an epicentral zone whose major axis lies magnetic N.—S. and its centre at 47°·6 N. and 70°·1 W. A preliminary examination of data for this earthquake indicates that it was of unusual severity, probably associated with considerable landslides in the clay beds and with its epicentre under the city of Quebec, near to that for the earthquake of February 28, 1925. R. S. R.

746. Forced Tides in a Lake. J. Proudman. *Roy. Astron. Soc., M.N. Geophys. Suppt.* 2. *pp.* 96–97, *Oct.*, 1928.

The effect of " free oscillations of the second class " in a landlocked body of water of small lateral extent and not too shallow is investigated, and it is shown that this is usually negligible, the ordinary forced tide following the " equilibrium law "; but when the period of such oscillations is appropriate there may be a simple superposition thereof, though owing to the additive way in which they enter, their effect would be eliminated in the process of analysis of a long series of observations. C. A. S.

747. Distribution of Tides in a Basin possessing a Line of Symmetry. J. Proudman. *Roy. Astron. Soc., M.N. Geophys. Suppt.* 2. *pp.* 98–101, *Oct.*, 1928.

The note deals with the dynamical theory of forced tides in a completely landlocked basin symmetrical both as regards coast-line and depth distribution about either (*a*) the equator, or (*b*) a meridian; the case (*c*) of a small sea similarly symmetrical about a parallel of latitude is also considered. It is shown that in all cases co-tidal and co-range lines are symmetrical about the line of symmetry of the basin. In (*a*) the line of symmetry (the equator) is also one of zero range for a diurnal and of zero normal current for a semi-diurnal constituent; in (*b*) and (*c*) the line of symmetry is a co-tidal line, possibly with reversion of phase at amphidromic points. C. A. S.

748. Curvature of Co-Tidal Lines across a Channel. J. Proudman. *Roy. Astron. Soc., M.N. Geophys. Suppt.* 2. *pp.* 111–119, *Oct.*, 1928.

Co-tidal lines in a channel of infinite length and uniform section, not symmetrical about the median line, are considered, when, in absence of the direct action of the astronomical disturbing forces, the distribution of the tides is determined by either the elevation or the longitudinal component of the current at the finite end, the motion at a great distance from that end thus reducing to a progressive wave. The effect of the earth's rotation and of frictional forces is neglected. Two cases are dealt with: (*a*) when the depth is uniform but different on each side of the median line; and (*b*) when the prescribed end-distributions of elevation and longitudinal current are uniform in both amplitude and phase. Provided that the breadth of the channel is small compared with the wave-length, it is shown that in case (*a*) the maximum deviation from straightness in the co-tidal lines occurs at a distance from the beginning of the channel somewhat less than a third of the breadth thereof, and is relatively negligible at a moderate multiple of that distance. The co-tidal lines strike the sides of the channel perpendicularly, and their curvature is very small. In case (*b*) the maximum deviation from straightness occurs at the beginning of the channel and is 2·7 times the maximum in case (*a*), and is thus still very small. C. A. S.

749. Analysis and Prediction of Tidal Currents from observations of Times of Slack Water. A. T. Doodson. *Roy. Soc., Proc.* 121. *pp.* 72–88, *Nov.* 1, 1928.

The paper provides a solution of the problem of obtaining harmonic constants for the principal tidal constituents representing current flow from a knowledge of the times of slack water only. The times of maximum current in either direction are also predicted from the same constituents, but the velocities of the maximum current can be stated only on an arbitrary scale unless a few values of the maximum currents have been observed. The method can be used to obtain fairly good approximations to the tidal elevation at a place from the times of high and low water or from the times of half-tide. The results are considered to be not of great exactness, but the predictions are sufficiently accurate to be included in standard time-tables. The method was described earlier [see Abstract 3192 (1928)]. R. S. R.

750. Orientation of Dunes and Wind Direction. L. Aufrère. *Comptes Rendus*, 187. *pp.* 833–835, *Nov.* 5, 1928.

Sand ridges may form as longitudinal dunes parallel to the predominating wind or as transverse dunes at right angles to the prevailing wind across wastes of sand. In tropical deserts, sand ridges and æolian valleys are symmetrical on both sides of the equator and form curves convex to the east, conforming to the deviation imposed on the trade-winds by the earth's rotation. Thus they register the prevailing wind, direction and trajectory, while secondary components show at the sides by other hollows. Those of the second type are discussed, their different slopes, and the differences in form across the deserts of North Africa. The effect of moisture in increasing the slope and making more permanent the dune is explained. Examples of these sand dunes in North and West Europe are also examined. **Erratum,** *ibid. p.* 964, *Nov.* 19, 1928. R. S. R.

751. Radium and Geology. C. S. Piggot. *Am. Chem. Soc., J.* 50. *pp.* 2910–2916, *Nov.*, 1928.

(1) Outlines the significance of radioactivity in geological problems. (2) Gives an account of measurements of the radium content of seven granites of the eastern seaboard of the U.S.A. (varying from $0\cdot378 \times 10^{-12}$ to $4\cdot826 \times 10^{-12}$ gm. radium per gramme of rock). The richest of these rocks was separated into its constituent minerals, and these tested separately; the radium was found to be most associated with the constituents of high specific gravity, and particularly with the micas. (3) Briefly discusses the importance in geophysics of the heat evolved by

the radio elements. (4) Discusses the difficulties of determining geologic ages by uranium-lead ratios, with special reference to the possible settlement of some of these difficulties by Aston with the mass-spectrograph.
H. R. R.

752. Analytical Determination of Uranium, Thorium and Lead as a Basis for Age-Calculations. C. N. Fenner. *Am. J. Sci.* 16. *pp.* 369–381, *Nov.*, 1928.

For calculations of geologic age from the content of U, Th and Pb in a mineral, a correct analysis is a fundamental requisite. Many minerals containing these elements do not present special difficulty, but with such as euxenite, polycrase and samarskite, Th and U are often precipitated with Ti, Ta and Cb, while with monazite phosphoric acids tend to deposit Th and rare earths at undesirable points. Detailed descriptions of methods of analysis are given, which have been found in practice to work well and to give apparently reliable results for the percentage amounts of U, Th and Pb.
R. S. R.

753. Radioactive Minerals from Divino de Uba, Brazil. C. N. Fenner. *Am. J. Sci.* 16. *pp.* 382–391, *Nov.*, 1928.

Among other minerals, specimens of monazite, a Th mineral containing little U, and samarskite, a U mineral containing little or no Th, were subjected to a preliminary treatment to remove decomposition products and then analysed for U, Th and Pb. The results indicate an age of $3 \cdot 6 \times 10^8$ years. Possible sources of error are discussed. Emphasis is laid on the importance of removing as completely as possible all decomposition products which may intrude deeply into the specimens and cause misleading conclusions to be made.
R. S. R.

ASTROPHYSICS.

754. Sub-Atomic Energy. A. S. Eddington. *Manchester Phil. Soc., Mem.* 72. *pp.* 101-117, 1917–1928. *Joule Memorial Lecture.*

A popular account of modern speculations as to the origin of solar and stellar energy. The inadequacy of the older hypotheses is pointed out, and the different ways in which sub-atomic energy may be released are considered. The breaking up of the nuclei of uranium, radium, thorium, etc., would not give a sufficient supply of energy to explain matters, even if the stars consisted entirely of uranium at their birth. The source of this uranium would be perfectly inexplicable. The building up of complex nuclei from simpler ones may result in the liberation of energy, as would be the case if four protons united with electrons to form a helium nucleus; $0 \cdot 8$ % of the mass would disappear in this case, being converted into energy; but on the whole the astronomical evidence is more favourable to the hypothesis that the stellar-radiated energy is due to the annihilation of electrons and protons, their mass being converted into radiant energy. Calls attention to the strong evidence that the masses of stars diminish with age. The fact that the theoretically calculated temperature at the centre of stars is close to 40 million degrees all along the Main Series, from the heaviest to the lightest stars, is very striking, and perhaps indicates that this is a kind of " boiling point " at which matter is converted into energy. The penetrating radiation of Hess may be due to sub-atomic processes; it seems likely that it has its origin in the nebulæ and in diffuse matter scattered through space, it certainly does not come from the interior of the stars. Considers the possibility of a counter-process in which radiation is converted into matter, but points out that even if such cycles take place the universe must in the end approach to a state of uniform changelessness. H. N. A.

755. Radiation-Equilibrium Integral Equation. V. Ambarzumian. *Zeits. f. Phys.* 52. 3–4. *pp.* 263–267, 1928.

Between a solution $\chi(\tau)$ of this equation and the resolvent $\Gamma(\tau, t)$ there is a relation $\frac{d}{d\tau}[\chi(\tau)] = \Gamma(O, \tau)$. A. D.

756. Standard Solar Wave-Lengths (3592–7148 Å.). K. Burns, W. F. Meggers and C. C. Kiess. *Dept. of Commerce, Bureau of Standards, Research Paper No.* 11. pp. 297–317, 1928.

In order to determine a series of solar wave-lengths in the international system to serve as standards for a new table of solar wave-lengths and to find the exact corrections which should be applied to Rowland's classical table of solar spectrum wave-lengths, the Bureau of Standards and the Allegheny Observatory cooperated in measuring the wave-lengths corresponding to selected dark (Fraunhofer) lines in the solar spectrum. The wave-lengths were compared with those of standard neon lines by the Fabry and Perot étalon-interferometer method, both spectra being photographed simultaneously. More than 11,000 observations were made on 729 solar lines in the wave-length interval (octave) from 3592·027 Å. in the ultra-violet to 7148·159 Å. in the red. The majority of these standard solar wave lengths have individual probable errors smaller than 1 part in 4,500,000. AUTHORS.

757. Catania Astrographic Catalogue. A. Bemporad. *Accad. Lincei, Atti,* 7. *pp.* 695–699, *May* 6, 1928.

An account of the progress made. It is expected that the reductions will be completed by the end of 1930. A. D.

758. Determination of Binary Star Orbits from Seven Observations. T. Vahlen. *Phys. Math. Soc. Japan, Proc.* 10. *pp.* 79–85, *May,* 1928. *In German.*

For the visible component of a binary system which consists of a bright and a dark star, the apparent orbit is the orthogonal projection of the true orbit, and hence must be an ellipse. It is here shown that the apparent orbit can be mathematically determined from seven observations of the bright star's position, and the true orbit can be found from this. The radial component of the motion, and the distinction between ascending and descending nodes, alone remain to be determined by spectroscopic observations. M. A. E.

759. Spectroscopic Orbit of H.R. 5702 and Velocity and Light Curves of 12 Lacertæ. W. H. Christie. *Dominion Astrophys. Obs., Victoria, Publ.* 4. 5. *pp.* 55–65, *Oct.,* 1927.

H.R. 5702.—Twenty-nine spectrograms form the basis of the determination of the orbit of this star. The most probable values of the elements as given by the least-squares solution are: $P = 3{\cdot}5753$ days, $\gamma = -25{\cdot}85$ km., $K = 58{\cdot}63$ km., $e = 0{\cdot}079$, $\omega = 24^\circ{\cdot}54$, T = J.D. 2,423,211·641.

12 *Lacertæ*.—Five series of spectrograms have been obtained and the velocity curves determined therefrom are given. Three series of direct extra-focal photographs of the variable and its field were obtained concurrently with three series of spectra, from which the variation in light was determined, thus correlating the velocity and light curves. An attempt to explain the peculiar behaviour of stars of this type has been made, assuming that the star is in the process of fission. This hypothesis appears to fit the observed data. AUTHOR.

760. Orbits of Two Helium Stars H.D. 19820 and H.D. 176853. J. A. Pearce. *Dominion Astrophys. Obs. Victoria, Publ.* 4. 6. *pp.* 67–79, *Dec.*, 1927.

The orbits of the spectroscopic components of H.D. 19820 (α $3^h\ 06^m\cdot 2$, $\delta + 59°\ 11'$, visual magnitude $7^m\cdot 09$, spectral type O8–O8) have been determined from 22 I-prism spectrograms. The elements are $P = 3\cdot 36897$ days, $e = 0\cdot 1019$, $\omega_1 = 300°\cdot 78$, $K_1 = 141\cdot 65$ km., $K_2 = 291\cdot 79$ km., $M_1 \sin^3 i = 18\cdot 88\ \odot$, $M_2 \sin^3 i = 9\cdot 17\ \odot$, $a \sin i = 19{,}975{,}000$ km. $= 28\cdot 7$ solar radii, and $\gamma = -\ 4\cdot 19$ km. The Hartmann interstellar calcium has a velocity of $-\ 14\cdot 6$ km. The spectrum contains all the lines characteristic of the class O8. The absolute magnitude computed by the luminosity method is $-\ 4^m\cdot 58$, and the resulting parallax is $0''\cdot 00039$ or 2560 parsecs.

The orbits of the spectroscopic components of H.D. 176853 (α $18^h\ 57^m\cdot 1$, $\delta - 10°\ 52'$, visual magnitude $6^m\cdot 68$, spectral class B5–B8) have been determined from fifteen spectrograms on eleven of which the secondary spectrum was measured. The following elements were derived from the twenty-two observations: $P = 1\cdot 849084$ days, $e = 0\cdot 033$, $\omega_1 = 156\cdot 16$, $K_1 = 150\cdot 58$ km., $K_2 = 241\cdot 18$ km. $m_1 \sin^3 i = 7\cdot 10\ \odot$, $m_2 \sin^3 i = 4\cdot 43\ \odot$, $a \sin i = 9{,}956{,}000$ km. $= 14\cdot 31$ solar radii, and $\gamma = -\ 12\cdot 86$ km. The absolute magnitudes computed by the luminosity method are in excellent agreement with Eddington's mass-luminosity theory, being $-\ 1\cdot 53$ and $-\ 0\cdot 38$ respectively, yielding a parallax of $0''\cdot 0019$, approximately 1700 light years. AUTHOR.

761. Theory of the Secular Perturbation of Higher Degrees. Y. Hagihara. *Phys. Math. Soc. Japan, Proc.* 10. *pp.* 87–113, *June, and pp.* 127–156, *July*, 1928. *In English.*

In continuation of former papers and using the new method which he there explained and developed, the author now proceeds to investigate all the simple types of commensurability of the first order in the theory of the motion of asteroids—that is, of the types 4/1, 3/2, 3/1, 2/1 and 1/1. The motion in the immediate neighbourhood of the commensurability-point is proved to be stable in the first four cases, and therefore the motion of asteroids belonging to the families Themis, Flora and Coronis is proved to be stable, including the secular perturbation of the third degree. The author refers to his own papers on "Families of Asteroids" in *Jap. Jour. Astr. Geophys.*, and to the work of Birkhoff, Whittaker, Hilbert, Hellinger and others. The treatment is purely mathematical.

He also extends the same method to deal with the secular perturbation of the fourth and higher degrees; and the general stability of the motion of asteroids in the neighbourhood of the commensurability-points of the first order is established. As to the exact positions of the instability regions, some vagueness remains, but in any case they are quite small, and only a few existing asteroids may be suspected of being in those regions. The present distribution of the asteroids is, therefore, not final, some being slightly unstable at present, but the solar system is evolving towards complete stability. M. A. E.

762. Analytical Theory of Perturbations and Poisson's Theory. H. Andoyer. *Comptes Rendus*, 187. *pp*. 622–624, *Oct*. 15, 1928.

From the system of equations, $dx/dt = \partial H/\partial y$, $dy/dt = \partial H/\partial x$, etc., the author derives a function K, such that $dK = H dt + \Sigma x dy + \Sigma C_q dq + (S + C_\mu) d\mu$, where C_q and C_μ are constants. He assumes that the qs are divided into two series, a and b, in such a way that b only appears through the intermediary argument l in the form $nt + b$, where the constant n depends on the as and on μ. He obtains the equations $\Sigma(\partial x/\partial\mu \,.\, \partial y/\partial q - \partial y/\partial\mu \,.\, \partial x/\partial q) = \partial S/\partial q + C_q$, where C_q is a linear function of t with constant coefficients. By taking μ as a perturbing parameter, he transforms these equations so as to exhibit in a simple manner the general properties of the different orders of the different elements. By writing the equations in the form (relative to the argument l)

$$\frac{\partial}{\partial\mu}\sum x\frac{\partial y}{\partial l} = \frac{\partial}{\partial l}\left(S + \sum x\frac{\partial y}{\partial\mu}\right) + c_l,$$

he shows that it contains Poisson's theorem and gives its full significance. A. S. D. M.

763. Stellar Radiation and Internal Constitution. T. Bialobrzeski. *J. de Physique et le Radium*, 9. *pp*. 237–248, *Aug*., 1928.

The author gives a summary of astrophysical theories, based chiefly on the four following works: Emden's *Thermodynamik der Himmelskörper*, Eddington's *Internal Constitution of the Stars*, Jean's *Astronomy and Cosmogony*, and Homer Lane's *The Theoretical Temperatures of the Sun*. He introduces an approximate formula, $\sigma = a\rho^{-1}T^{5/2}$, which he has found for the relationship between the energy (σ) radiated by unit mass as a function of the mean density and temperature of the star; this is in good accordance with the results of astronomical observation. A. S. D. M.

764. Proper Motions. W. J. Luyten. *Harvard Coll. Obs., Circ. No.* 327. *pp*. 1–11, 1928.

Five hundred proper motions found with the Blink microscope.

765. Personal Equation in the Hour Determination by Transit with the Impersonal Micrometer. N. Stoyko. *Comptes Rendus*, 187. *pp*. 713–715, *Oct*. 22, 1928.

An extension of the author's previous paper [see Abstract 81 (1929)], which takes into consideration the principal personal errors of this instrument, those of motion and of bissection. Accepting the previous notation, and that systematic error is proportional to sec. δ, he brings into the equation of motion for Paris the corrective term, $x = (n_s - n_i)/(0{\cdot}95 + 0{\cdot}77)$, and finds that for the resulting C_p there is no systematic error. For the equation of bissection he finds that to make the correction to C_p, zero, we musthave $\Sigma\,(\tan\phi - \tan\delta) = \Sigma \sec\delta_h - \Sigma \sec.\ \delta_{h'}$. a condition which is easy to fulfil by a proper choice of clock stars. A. S. D. M.

LIGHT.

766. Investigation of the Laws of Colour. A. Klughardt. *Zeits. f. techn. Phys.* 9. 10. *pp.* 382–390, 1928.

The results obtained by an analysis of the colour composition of a number of cottons of different colours are discussed. In a table, the relative brightness, colour components, white admixture and spectral limits of the equivalent primary colours are given for each sample. The results differ from the Ostwald coefficients by more than possible experimental errors, the difference being least for yellows and one purple sample. Total colour-phenomena with equal colour-tones must thus be expressed with quite different spectral limits for equivalent primary colours if they belong to different pieces regarding white admixture and brightness. It is concluded that Ostwald's transformations of remission curves in the normal form with sharp limits and simultaneous observance of colour principles is impossible. The results obtained confirm the views of C. Schaefer. [See Abstracts 2313 (1926) and 2853 (1927).] R. S. R.

767. Coloration of Salts. K. Przibram. *Akad. Wiss. Wien, Ber.* 137. 2*a*. *No.* 7. *pp.* 409–419, 1928.

Previous observations on the action of pressure on the coloration of rock-salt [see Abstract 1872 (1928)] have now been confirmed and extended. Crystals withdrawn from the molten material, which colour very quickly and intensely, show no augmentation of this property when subjected to moderate pressure, but under high pressures show the blue pressure-colour. For the depression of the ability to turn blue under very high pressure the duration of the pressure is of predominating importance. As regards the reversion of the pressed blue salt to yellow under renewed pressure, characteristic differences appear with blue colorations produced in different ways. The blue pressed salt is shown by ultra-microscopic investigation to be virtually optically empty, and it may be regarded as an intermediate state between the yellow stage and that coloured blue by ultra-microns. Doubt remains as to whether the magnitude of the particles is a determining factor in the coloration. Ottmer's results regarding the coloration of alkali halides [see Abstract 1597 (1928)] confirm the author's diagonal law and the observed dependency of the stability of the coloration on the strength of the electron linkings.

T. H. P.

768. Effect of Temperature Change on the Colour of Red and Yellow Lovibond Glasses. D. B. Judd. *Dept. of Commerce, Bureau of Standards, Research Paper No.* 31. *pp.* 859–866, 1928.

The spectral transmission at twelve wave-lengths in the visible spectrum of two Lovibond glasses (35Y and 7·2R) has been carefully determined at 15° C. and at 40° C. From these spectral transmission data the colour-changes corresponding to the temperature interval of 25° C. have been computed. It was found, both for 35Y alone and for the 35Y + 7·2R combination, that an increase of 25° C. is the practical colorimetric equivalent of adding 0·2 in Lovibond red units. This difference is almost negligible in the colour-grading of cotton-seed oil. Preliminary work on two samples of cotton-seed oil indicates that the oil changes in colour with change in temperature even less than the glasses do. If all oils behave like these two samples, only extreme variations (more than 15° C.) in temperature need be taken into account in colour-grading cotton-seed oil with Lovibond glasses. AUTHOR.

769. Passage of Light through Turbid Media. P. Gruner. *Helv. Phys. Acta,* 1. 1. *pp.* 1–13, 1928. *In German.*

Points out that the phenomena accompanying the transmission of light by translucent media cannot be set down directly from the law of light scattering by a single particle. Works out in detail the case of the light scattered in the plane of incidence when a narrow unpolarised beam falls on a plane parallel layer of a turbid medium. The discussion, which is mathematical, is illustrated by curves and tables. [See also Blumer, Abstracts 1850 (1925), 2585 (1926), 667 and 670 (1927).] H. R. R.

770. Refractive Index of Quartz. W. R. C. C. Adams. *Roy. Soc., Proc.* 121. *pp.* 476–477, *Nov.* 1, 1928.

The following equation has been found for the refractive index of the extraordinary ray; it has been worked out in a similar manner to that employed for the ordinary ray [see Abstract 595 (1928)]:—

$$n^2 = 3\cdot5612557 + \frac{0\cdot00844614}{\lambda^2 - 0\cdot0127493} + \frac{0\cdot00276113}{\lambda^2 - 0\cdot000974} + \frac{127\cdot2}{\lambda^2 - 108}.$$

A table shows the calculated and observed refractive indices for eighteen lines in the visible and ultra-violet. Most of the refractive indices which have been determined in the infra-red are for the ordinary ray. H. N. A.

771. Expression of Refractivity. R. de Mallemann. *Comptes Rendus,* 187. *pp.* 888–890, *Nov.* 12, 1928.

The refractivity and rotatory power of an isotropic liquid can be expressed as a function of the refractivity and rotatory power of the gas, the molecular diameter, and the density of the liquid. Formulæ are given which show that to a first approximation the refractivity $\frac{M}{d}(n^2 - 1)$ is a linear function of the density. This method can be used either to calculate the molecular diameter σ, or to correct the formula of Lorentz, which is regarded as an empirical approximation. T. M. L.

772. Newton's Rings. V. Ronchi and G. Giotti. *N. Cimento,* 5. *pp.* 265–270, *July,* 1928.

The author treats Newton's rings as the interference fringes produced by two coaxial segments of non-concentric spherical waves. He shows that it is thus possible to determine the position of the rings in space. He first treats the general problem and then applies the results to the ordinary practical case of the rings produced by a spherical and a plane surface. The localisation of the rings explains a phenomenon noticed in connection with the Zeiss spectrograph used with the 102-cm. reflector of the observatory of Merate, *viz.*, the ribbed appearance of the spectrum under certain conditions. J. W. T. W.

773. Optical Interference Method for Investigation of Membranes. P. Paasche. *Zeits. f. techn. Phys.* 9. 10. *pp.* 411–414, 1928.

Full particulars are given of a stroboscopic interference method for the measurement of the displacement of an electrically excited oscillating membrane. The membrane is a Telefunken loud-speaker membrane, and its basic frequency is the same as that of the current of the high-frequency machine, and that in turn about equal to the frequency of the stroboscopic light impulses. Curves show (1) the resonance curve of a part of the membrane; (2) the phase of maximum amplitude in the resonance region; and (3) the time-amplitude curve of the membrane with constant frequency in the resonance region. R. S. R.

774. Optical Representation of Non-Self-Illuminated Objects. H. Boas. *Zeits. f. Phys.* 52. 3–4. *pp.* 287–298, 1928.

Discusses the work of Siedentopf [see Abstract 3211 (1928)] on the same subject, and shows that no difference exists in the power of resolution of diatoms if they are vertically or obliquely illuminated. Siedentopf's results were in disagreement with this theory, and the present author explains this difference by the fact that Siedentopf did not use an equivalent pencil of rays for illumination purposes. With diatoms in silver iodide, a marked increase in the visibility of their surface structure is obtained, and when treated in this manner they show similar resolutions with vertical or oblique illumination as well as with general direct illumination. R. C. F.

775. Theorem of Malus-Dupin. G. Giotti. *N. Cimento,* 5. *pp.* 271–272, *July,* 1928.

This theorem states that any ray proceeding from a point source of light remains normal to the wave surface after reflection or refraction. The author gives a mathematical demonstration of the truth of this theorem, based upon Fermat's principle. J. W. T. W.

776. Determination of Width of Image from Photographs. A. Hornoch. *Zeits. f. Instrumentenk.* 48. *pp.* 491–496, *Oct.,* 1928.

Mathematical. A method, simpler than that previously proposed [see Abstract 1232 (1928)], is given for determining the width of the image and the position of the cardinal point from photographs. L. L. B.

777. Calculation of Second Order Quantities through an Optical System. M. Herzberger. *Zeits. f. angew Math. u. Mechanik,* 8. *pp.* 396–402, *Oct.,* 1928.

The author shows how by vectorial methods important problems can be solved without prolonged calculations and the results transformed so as to be of practical importance. This is treated in detail for a bundle of rays travelling to a refracting system. The laws for zero, first and second orders, are found, and, finally, formulæ are established for the meridional rays of a rotating symmetrical system. The paper is wholly mathematical. R. S. R.

778. New First Order Theodolite. D. L. Parkhurst. *Frank. Inst., J.* 206. *pp.* 623–629, *Nov.,* 1928.

The theodolite is used by the United States Coast and Geodetic Survey, and its requirements were ruggedness, speed in manipulation, and simple and easy adjustment in the field. The 9-in. circle is graduated to 5′ and can be read by micrometer microscopes to 1″. The circle bearing is separate from the telescope element and has no clamp. The telescope is of the internal focussing pattern, to avoid troubles due to dust and damp. A 6-in. 10″ circle is used for vertical angle measurements. The bearing surfaces of the vertical axis and of the circle are designed to avoid changes of fit due to changes of temperature, two conical surfaces of different slopes being employed. All measurements are made at night to avoid refraction errors in the air, and an arrangement is used to obtain almost uniform illumination for cross wires and circles. R. S. R.

779. Accuracy of a Wild Precision Theodolite. F. Ackerl. *Zeits. f. Instrumentenk.* 48. *pp.* 517–523, *Nov.*, 1928.

The method of obtaining the error curve for the divisions of the horizontal circle from numerous observations on the theodolite is clearly demonstrated. The error curve from 0°–180° for the instrument used is also given. R. C. F.

780. Modern Photographic Telescope and the New Astronomical Telescope. Part III. Ritchey-Chrétien Aplanatic Reflector. G. W. Ritchey. *Roy. Astron. Soc. Canada, J.* 22. *pp.* 303–324, *Oct.*, 1928.

The author enumerates the advantages possessed by the Ritchey-Chrétien reflector over other types, and for comparison shows the results to be expected when photographing a dense globular star cluster with this reflector and with a Newtonian reflector. [See also Abstracts 2664 (1928) and 106 (1929).] R. S. R.

781. New Form of Comet Discoverer. G. Bigourdan. *Comptes Rendus,* 187. *pp.* 689–693, *Oct.* 22, 1928.

Particulars are given of a new form of mounting employed for a close search of the heavens. The telescope is vertical and rotates about its optic axis, while directed to the nadir. A plane mirror with rotation about a horizontal axis is fixed to the telescope, and successively all parts of the sky can be seen. The observer is at rest while observing, and difficulties due to the use of counterpoise weights are avoided. R. S. R.

782. Sine Conditions, Cosine Relation, Isoplanar and Homoplanar Conditions, their Connection with Energy Reflection, and their Divergence from Fermat's Law. M. Herzberger. *Zeits. f. Instrumentenk.* 48. *pp.* 313–327, *July;* 465–490, *Oct., and pp.* 524–540, *Nov.*, 1928.

Owing to doubt as to the validity and range of applicability of the laws relating to lenses, the author attempts theoretically to interconnect the whole complexity of questions relating to this subject. In the first part general laws are briefly discussed and the Straubel and cosine laws are particularly considered. The question of the Straubel laws for the bundle of rays in space and also for the flat bunch of rays are dealt with, and for the cosine law, the portraying of a line element, an element of surface and an element in space are fully discussed. The second part, which deals with the application of previous work on systems symmetrical about the axis considers, firstly, the portraying of a point on the axis, and, secondly, the point when not situated on the axis. With the point on the axis two cases are discussed: when it is portrayed as a point, considering the Hockin and Abbes conditions, and when it is not portrayed as a point, dealing with the factors affecting it. For the case of the point not on the axis, three typical examples are considered: the point exactly portrayed, the point corresponding to a rotation symmetrical caustic, and the point corresponding only to a single symmetrical caustic. These are further subdivided, and from the complete discussion in this second part conditions are given under which, in a rotation symmetrical optical system, a surface element lying on or outside the axis can be portrayed either by isoplanar or homoplanar conditions. In the concluding part the portraying of a finite surface by a bundle of rays of finite dimensions in a rotation symmetrical system is dealt with by considering the homoplanar and isoplanar portraying of the finite surface and the conjugate. Finally, a good *résumé* of the literature on this subject is given. R. C. F.

783. Dependence of Spherical Aberration of Meridional Rays on the Position of the Object and the Observer's Eye. E. Jachontow. *Zeits. f. Instrumentenk.* 48. *pp.* 540–547, *Nov.*, 1928.

Expressions are obtained connecting the coefficients of spherical aberration with the constants of the system and the distances of the object and the observer's eye from the optical axis of the system. R. S. R.

784. Diffusion of Light and of Hertzian Waves by Free Electrons. C. Fabry. *Comptes Rendus*, 187. *pp.* 777–781, *Nov.* 5, 1928.

An electron placed on the path of a bundle of electromagnetic radiations takes a vibratory motion under the action of the electric field of the wave and in its turn radiates in all directions. The phenomenon resembles molecular diffusion, but whilst this is more intense as the frequency is higher, the free electron gives, when the intensity of the incident wave is the same, an intensity of diffused radiation independent of the frequency. The author gives a simple form of calculation, supposing the classical laws of mechanics and electrodynamics applicable and without intervention of quanta. The free electron diffuses six times the energy that it intercepts. It diffuses the energy that the wave transmits across a surface of area $6 \cdot 8 \times 10^{-25}$ cm.^{2} These results are independent of the wave-length, and apply to radio-telegraphic waves as well as to luminous radiations. But in reality the waves meet not one electron but a very great number of electrons, and the result is very different in different cases. The diffusion of light by the electrons is always very slight whilst with the waves used in wireless telegraphy the electrons assume concordant motions and send into space waves whose amplitudes are added, giving an intensity enormously greater than the sum of the intensities which would be produced by the individual charges. In different cases a true regular reflection over an ionised region of space would be obtained or an important diffusion in all directions. Between these two extreme cases all intermediate cases are possible. Taking account of the concordance of phase amongst electrons vibrating in a sufficiently large volume, there may be diffusion or reflection more or less regular without the number of electrons being extremely high. J. J. S.

785. Secondary Radiations in Molecular Diffusion of Light by Liquids. P. Daure. *Comptes Rendus*, 187. *pp.* 826–828, *Nov.* 5, 1928.

The photometric study of the relation between the intensities of two Raman rays of opposite characteristics does not as yet lead to any definite result; but if we compare two secondary rays of the same frequency excited by two different radiations, we find a relation between them Let I_1 and I_2 be the respective intensities of these radiations D_1 and D the intensities of these radiations normally diffused by the liquid, S_1 and S_2 the intensities of the corresponding Raman rays; then $D_2/I_2 = 2\cdot5 \, . \, D_1/I_1$; $S_2/I_2 = 1\cdot5 \, . \, S_1/I_1$. A. D.

786. Presence of Two Different Magnetic Rotatory Powers in a Uni-Axial Crystal Along and Perpendicular to the Axis. J. Becquerel. *Zeits. f. Phys.* 52. 5–6. *pp.* 342–355, 1928.

The magnetic rotatory power of a uni-axial crystal has been determined in directions inclined to the optic axis for tysonite. This crystal is very suitable for the purpose, since its magnetic rotation is very great and its double refraction very small, whilst a construction given by H. Poincaré enables the rotatory power to be separated from the combined effect. It is shown that the magnetic rotatory power of tysonite decreases if the angle between the incident ray and optical axis increases. If two magnetic rotatory powers be assumed along and perpendicular to the axis respectively, a generalisation of the Verdet law is afforded which is in excellent agreement with observation. H. H. Ho.

787. Polarisation of Light from Canal Rays in Weak Electrical Fields. Part II. H_β Light with Different Arrangements of Field. E. Rupp. *Ann. d. Physik*, 87. 3. *pp.* 285–297, *Oct.* 12, 1928.

The effect of weak electrical fields on the polarisation relation I_p/I_s has been investigated for different field arrangements, homogeneous transverse field, homogeneous longitudinal field, field at 45° to the ray, non-homogeneous field. In the first two cases no effect of the field could be observed; in the third case there were periodical variations in the polarisation ratio along the path of the canal ray, the fading path or *Abklingweg*. The case of the non-homogeneous field corresponds to earlier experiments of the author, and periodical variations in the polarisation ratio were observed. The results are in qualitative agreement with the theory of the anharmonic oscillator, which vibrates in different phases along the path on which the light fades away. It appears that unpolarised light from a canal ray becomes polarised again when the atoms of the ray fly past an obstacle. [For Part I see Abstract 1891 (1928).] H. N. A.

788. Polarisation and the Light Quantum Theory. J. Ullmo. *Comptes Rendus*, 187. *pp.* 758–761, *Oct.* 29, 1928.

Shows that the polarisation phenomena can be interpreted as statistical effects due to the distribution and to the disposition of the photons in space rather than to the structure of the luminous particle. The photons are considered to have impenetrable reciprocal actions and a length in the direction of propagation equal to that of a wave. The natural light should be analogous to that of a vitreous body in which the atoms are distributed haphazardly with, however, a constant density and mean distances which are a function of their mutual action. The groups of photons are considered to have a simple local disposition, their transversal distance thus being the natural separation. With these hypotheses, and considering alignment, birefringent analyser, Brewster's law, Wiener's results, polarisation by diffusion, Fresnel-Arago's results, rotary polarisation and selective photoelectric effect, it is shown that the theory developed remains correct if it can be admitted that the photon has no longitudinal dimensions, but is simply a point variable over a distance of one wavelength. This corresponds to Pauli's statistics. R. C. F.

789. Photometric and Spectrophotometric Studies. Part VI. Reflection Spectroscopy. K. Schaum. *Zeits. f. wiss. Phot.* 26. 4–6. *pp.* 97–110, *Oct.*, 1928.

When the materials under test cannot be formed into light-transmitting plates—*e.g.*, powders—reflection spectroscopy has to be resorted to. Measurements were made by means of a König-Martens spectrophotometer on a number of inorganic pigments and azo dyes, in order to show the applicability of the method. Results are also given for a number of azo-benzol dyes and dye-coated mirrors. The conditions under which reflection spectroscopic studies can give information as to the nature of the pigments, dyes and mordants are also considered. R. C. F.

790. Sensitisation of Photographic Emulsions by Colloidal Materials. B. H. Carroll and D. Hubbard. *Dept. of Commerce, Bureau of Standards, Research Paper No.* 20. *pp.* 565-588, 1928.

Photographic sensitivity is apparently greatly increased by the presence of ultra-microscopic particles of the silver halide grains. Theories regarding this effect are discussed, and methods are developed whereby colloidal particles are introduced into photographic emulsions to test the possibility of their adsorption by the emulsion grains and whether they function as sensitising nuclei. A number of ammoniacal and neutral emulsions and also emulsions with the silver halide grains positively charged were tried, whilst the colloidal solutions were silver iodide, silver sulphide, metallic silver and gold. The positively charged silver halide emulsions were particularly suited to sensitisation by negatively charged metallic colloids, whilst all the colloids retarded after-ripening to such an extent that desensitisation resulted. Colloidal silver iodide, with chemical development, produced a definite increase in contrast and a great increase in speed when physical development was used, both these effects being explained by acceleration of development. The metallic colloids increased the emulsion speed at constant or decreased contrast, this being due, not to development acceleration, but to the localisation of the photochemical action in the grain around the nucleus, thus increasing developability. Only negative results were obtained with colloidal silver sulphide. R. C. F.

791. Mercury Cyanide as a Desensitiser. H. Meyer and R. Walter. *Zeits. f. wiss. Phot.* 26. 4–6. *pp.* 165–170, *Oct.*, 1928.

The addition of mercury cyanide to a developer produces a useful and practical desensitiser, and for development in bright light all the usual organic developers except pyrogallol are suitable for mixing with it. There does not appear to be a chemical combination between the developer and the mercury cyanide, but the latter remains in the developer in the form of an alkali mercury cyanide complex which is not reduced by the developer. Colloidal silver also is oxidised by a developer containing mercury cyanide, this being probably the action which produces desensitisation. R. C. F.

792. Dye Sensitisers and Suitable Dyes for the Bleaching-Out Process. M. Mudrovčić. *Zeits. f. wiss. Phot.* 26. 5. *pp.* 171–192, *Oct.*, 1928.

Describes the results of experiments on numerous dyes, whereby the author has attempted to classify the dyes with which thiosinamin and its derivatives work most efficiently. The action of the substitution of the hydrogen in thiourea and thiosinamin by other groups on the sensitising action of the compound is also treated, and several new sensitisers are found. A few piperonal derivatives are also considered. The question of bleaching is dealt with, and from the results it is shown that for sensitising with thiosinamin and its derivatives the thiazine, oxazine and azine groups are the most suitable. Then follows pyronine with the triphenyl-, akridin-, nitro- and some azo dyes considerably less suitable. Tartrazin is almost non-sensitive. Finally, the most suitable dyes for coloured prints, obtained by means of the bleaching-out process, and their methods of use, are given. [See also Abstract 1901 (1928).] R. C. F.

793. Fogging by Acids and Oxidising Agents, and the Intensification of the Photographic Latent Image. E. P. Wightman. *Am. Chem. Soc., J.* 50. *pp.* 2923–2929, *Nov.*, 1928.

The author's hypothesis explaining the action of certain oxiding agents and acids in producing latent fog has been questioned by Lüppo-Cramer. This paper gives further arguments in favour of the author's hypothesis that the formation of latent fog is probably due to bromine being formed by the oxidising salts and acids from the soluble bromide in the plate. Additional experimental results are also given. The facts quoted by Lüppo-Cramer, as opposing the above hypothesis, are also explained. [See Abstract 896 (1928).] R. C. F.

794. Law of Blackening of Photographic Plates at Low Densities. E. A. Baker. *Roy. Soc. Edinburgh, Proc.* 48. *pp.* 106–133, 1927–1928.

Theoretically examines the proportions of a number of absorbing and emitting systems subjected to radiation, which undergo given sequences of absorptions and emissions. Assuming that in exposure the grain acts as a single system, the results obtained from the above, considering only small proportions to be affected, are applied to the photographic action, when it is shown that for "full" development two successive absorptions are necessary. For "partial" development three absorptions and one intermediate emission are necessary, and these results are found to be experimentally true for a wide wave-length range. A quantitative theory developed gives excellent agreement with known results relating to pre-exposure, inefficiency of short exposure to intense light, proportions of small grains affected by different exposures in single-layer plates, and the influence of development on Schwarzschild's index. The process termed "emission," although it is spontaneous, does not obey the unimolecular law, this being shown by the disagreement, for long exposures, between theory and experiment with regard to the curves of constant blackening. Finally, a new formula for the characteristic curve of a plate with uniform grains, which is correct over the low and moderate density regions, is derived. [See also Abstracts 1862 (1925) and 2877 (1927.] R. C. F.

795. Photoelectric Polarimetry and Photometry. E. Perucca. *Accad. Lincei, Atti,* 7. *pp.* 733–735, *May* 6, 1928.

Todesco put forward a method [see Abstract 2102 (1928)] for putting in evidence small birefringences by photoelectric means. The author thinks that Todesco's method is not so well adapted for birefringences, but is excellent for polarimetric and photometric measurements. A. D.

796. Theoretical Principles of Flicker Photometry. Part I. Flicker Photometric Laws for Dark Vision. P. Lasareff. *Zeits. f. Phys.* 52. 1–2. *pp.* 119–125, 1928.

In this theoretical paper the author makes use of his ionic theory of sight [see Abstract 1703 (1927)] to explain the phenomenon of flicker photometry and to develop quantitative laws of flicker photometry with dark vision. General equations of the photochemistry of the retina for constant and periodic illumination are first developed, and, from the assumption that two light sources produce similar sensations on the retina if the material variations in the retina are identical, the conditions of the identity of the sensations can be found. Talbot's law is then developed from these formulæ, and it is shown that two differently coloured light sources acting alternately on the same retinal spot produce a continuous sensation when these two light sources individually give a continuous sensation at the same frequency of light and dark oscillations. Finally, the flicker and edge values for vision at the edge of the retina are shown to be identical. R. C. F.

797. Fluorescence and Solid Solution. Mabel K. Slattery. *Nat. Acad. Sci., Proc.* 14. *pp.* 777–782, *Oct.*, 1928.

Discusses the rôle of uranium in endowing inorganic salts with fluorescent properties. Gives details of the fluorescence spectra of lithium and sodium fluoride fluorophors containing traces of uranium. X-ray diffraction photographs of NaF and LiF containing ½ % of uranium (the maximum amount for good fluorescence) show no change in the crystal structure as a result of the addition of the uranium. This is in opposition to the views of Ewles [see Abstract 1565 (1926)]. It is suggested that a uranium atom may replace a lithium atom here and there in solid solution in LiF without deforming the lattice. Fluorophors with different lattice constants —prepared by fusing mixtures of LiF and NaF in different proportions, with a trace (1/20 %) of uranium—show shifts of the fluorescence lines. In every case increase of lattice constant shifts the lines in the direction of increasing wave-length. This contrasts with Travniček's observations on samarium phosphors [see Abstract 910 (1928)]. An explanation of this is suggested in terms of the peculiar external electronic configurations of the rare earth atoms. H. R. R.

798. Structure of the Phosphorescence Centre in CaS. F. Bandow. *Ann. d. Physik*, 87. 4. *pp.* 469–508, *Oct.* 12, 1928.

In the case of CaSCuα, CaSMnα, CaSBiα the addition of fluoride flux is necessary for a large light output. The distribution of the duration centres is affected by the addition of Na_2SO_4 and $Na_2B_4O_7$, but not by fluoride. The optimum amount of fluoride decreases with decreasing active metal content. Phosphors made from pure CaS (with no flux) could give the same light sum as those containing flux. The addition of CaO decreases the light sum in proportion to its concentration. It is thought that the effect of the fluoride flux is not to alter the centres but to affect the number of the electrons removable from the centres. The evidence goes to show that all the phosphor is in the form of centres. J. E.

799. Phosphorescence of Fused Quartz. A. C. Bailey and J. W. Woodrow. *Phil. Mag.* 6. *pp.* 1104–1107, *Dec.*, 1928.

Many samples of fused quartz possess the properties of a phosphorescent body—that is, they can be excited by ultra-violet light; they will then

emit a visible phosphorescent light of considerable strength upon the application of heat, and they can be completely de-activated by bringing them to a red-heat in a flame. This phosphorescent activity of fused quartz is not uniform, but there is a wide variation between samples and even within the area of a single small piece. Natural quartz crystals do not possess this property of emitting a phosphorescent radiation, but they can be brought into this condition by heating slowly in an electric furnace to a temperature of 1600° C. Pyrex glass, calcite and fluorite exhibit a prominent phosphorescent activity, but gypsum does not.
AUTHORS.

800. Origin of the Phosphorescence of Phosphorus. A. Petrikaln. *Zeits. f. Phys.* 51. 5–6. *pp.* 395–409, 1928.

In a former paper it was supposed that the phosphorescence of phosphorus was due to the pentoxide [see Abstract 1597 (1924)]. With this idea in mind, the spectra of the trioxide and the pentoxide have been studied. Gaseous pentoxide showed under electron stimulation only the spectrum of oxygen, and there is no absorption down to the absorption of quartz. The trioxide, however, under electron stimulation gives the phosphorescence spectrum. The trioxide spectrum consists of a continuous region in the visible and two systems of bands. One system can be completely analysed; the other partially so. A band head-level scheme is given for the first. It is supposed that the continuous spectrum is due to the solid pentoxide. The excitation conditions of the trioxide in the oxidation of phosphorus are discussed.
J. E.

801. Propagation of Light through Fields of Force. Part II. F. J. v. Wisniewski. *Zeits. f. Phys.* 51. 5–6. *pp.* 443–450, 1928.

An attempt to account for the velocity of light in material media by the influence of the electromagnetic field of the medium. Entirely mathematical and based on a combination of wave mechanics with classical electromagnetic theory. [For Part I see Abstract 480 (1929).]
J. E.

802. Propagation of Light through Fields of Force. F. J. v. Wisniewski. *Zeits. f. Phys.* 52. 3–4. *pp.* 280–286, 1928.

The wave equation of light propagation in a gravitation field is deduced under the assumption of a non-Euclidian space. Entirely mathematical. [See Abstract 480 (1929) and preceding Abstract.]
J. E.

803. Light Emission of the Atom. J. Kleiber. *Ann. d. Physik,* 87. 4. *pp.* 461–468, *Oct.* 12, 1928.

The simple Bohr model with the electrons rotating about the nucleus in circular orbits corresponding to the different shells K, L, etc., is taken as base. The emission process is then regarded as due to an oscillation superimposed on the normal orbital motion, and brought about by the effective diminution of the nuclear charge when a "foreign" electron passes very close to the nucleus. Each orbit oscillates with a particular frequency, and the "difference tones" of these are shown to equal the frequencies of the Balmer series.
W. S. S.

804. Amount of Uniformly Diffused Light that will go in Series through Two Apertures Forming Opposite Faces of a Cube. L. F. Richardson. *Phil. Mag.* 6. *pp.* 1019–1023, *Nov.*, 1928.

As an example of the problem, the radiation might be supposed to come out of a blackened enclosure at uniform temperature through one aperture, across the cube, and through the other aperture into a calorimeter, the problem being to find Stefan's constant. The integral to be evaluated is $\iiiint \cos \zeta_1 . dA_1 . \cos \zeta_2 . dA_2/r^2$, where dA_1, dA_2 are elements of area of the apertures, r the distance between the centres of dA_1 and dA_2, and ζ_1, ζ_2 the angles between the normals to dA_1, dA_2 and the line joining dA_1 to dA_2. It is concluded that the amount of light, uniformly diffused with brightness I, that will go in series through two apertures forming opposite faces of a cube of edge l is $(0 \cdot 6278 \pm 0 \cdot 0001)l^2$I.

T. B.

805. Spectrum of CdIII. J. C. McLennan, A. B. McLay and M. F. Crawford. *Roy. Soc. Canada, Trans.* 22. *Sect.* 3. *pp.* 45–54, *Jan.*, 1928.

The structure of CdIII is isoelectronic with PdI and AgII. Since the spectra of both these structures have been put in order, CdIII was next attacked, using the irregular doublet law and the relativistic doublet formula as guides. The spark spectrum of Cd in air was photographed between 2250 Å.U. and 1850 Å.U., and the spark spectrum of Cd in H was measured with a fluorite spectrograph between 1850 Å.U. and 1450 Å.U. The chief wave-lengths result from transitions $d^9p \rightarrow d^9s$. The multiplets are similar to those in analogous spectra. An extension has also been made to the CdII spectrum by the discovery of the multiplet $^2D - {}^2P$.

A. C. M.

806. Influence of Argon on the Sulphur Spectrum. J. C. McLennan, R. Ruedy and L. Howlett. *Roy. Soc. Canada, Trans.* 22. *Sect.* 3. *pp.* 79–86, *Jan.*, 1928.

Spark spectra of sulphur were obtained from sulphur dioxide, using a 2-kVA transformer with capacity and a quenched gap. At low pressures of SO_2 the introduction of a little argon suppressed the spark spectra of sulphur and brought out the arc series lines. While the sulphur lines steadily increased in intensity with increase of current, the argon lines tended to a maximum when the current through the primary of the transformer was about 15 amperes. The results were duplicated, using the electrodeless discharge. The arc lines were obtained with less good intensity.

A. C. M.

807. Afterglow in Air. W. Bernhardt. *Acad. Polonaise Sci. et Lettres, Bull.* 3a. *pp.* 69–83, *March*, 1928. *In French.*

The afterglow is examined in air in a tube at different pressures. The fall of potential across the free path of a molecule is decisive in giving rise to molecules capable of giving rise to the afterglow. The afterglow exhibits varying shades of green under pressures varying between some hundredths of millimetres of mercury and 170 mm. In addition there is a yellow afterglow, excited by high-tension discharges, observed when the pressure is from 30 to 40 mm. The time of retardation of the green luminescence diminishes with increase of pressure. It varies from 0·01 sec. to more than 20 sec. The spectra of the green and the yellow afterglows are continuous. The afterglow is limited to a temperature-range from − 130° to + 200° C.

A. C. M.

808. Continuous Spectrum and Arc Spectrum of Bromine. N. Siracusano. *N. Cimento*, 5. *pp.* 273–283, *July*, 1928.

The spectrum of bromine was obtained with the electrodeless discharge and examined in the region 3000–2100 Å.U. The possibility of regulating at will the conditions of excitation and operating in an atmosphere of very pure gas permitted the attaining of new results. In this first note on the experiments the following points are dealt with: (1) A spectrum completely continuous has been obtained; (2) the continuous band 2930 (Fowler and Strutt) undergoes an evolution with variation of the excitation which causes to be retained the continuous spectrum appertaining to an energy level lower than that which produces this band; (3) the arc spectrum in this region was identified. J. J. S.

809. Intensities of Forbidden Lines in Magnetic Fields. W. C. van Geel. *Zeits. f. Phys.* 51. 1–2. *pp.* 51–61, 1928.

The intensities of the forbidden lines in the *pd* multiplets of ZnI have been measured in various magnetic fields and their intensities compared with those of orthodox lines. The intensities of the p_0d_2 and p_1d_3 lines increase approximately as the squares of the field-strengths; the intensity of the line p_0d_3 is very small. The symmetrical σ-component of p_0d_2 are not equally strong; this lack of symmetry in the intensities increases with a power of the field-strength somewhat less than 3. Also for p_0d_2 the polarisation rule no longer holds; the ratio of the sum of the π-components to the sum of the σ-components is almost 4 : 3. Similar results were found for p_1d_3. The results are in the main in good agreement with the theoretical requirements of Zwaan (see next Abstract).

A. C. M.

810. Intensities in the Incipient Paschen-Back Effect. A. Zwaan. *Zeits. f. Phys.* 51. 1–2. *pp.* 62–70, 1928.

In the preceding abstract is given an account of experimental work on the intensities of the forbidden lines in the ($2p - 3d$) multiplets of ZnI. In this paper the author has used the Jordan-Heisenberg matrix theory of the Zeeman effect to calculate the dependence of the intensities of the *pd* components on the magnetic field. It is shown that the Heisenberg-Jordan results are equivalent to the eigen function calculations of C. G. Darwin. A. C. M.

811. Polarisation of Zinc Resonance Lines. P. Soleillet. *Comptes Rendus,* 187. *pp.* 723–725, *Oct.* 22, 1928.

In this continuation of previous work [see Abstract 3032 (1928)], the line $\lambda = 3076$ of zinc is examined. For a magnetic field along the exciting beam a maximum value of polarisation of 67 % is found, while for such a field along the direction of the observed beam there is only polarisation for extremely small fields, *viz.,* about half the above value for a field of 0·004 gauss. The mean life of the atom is calculated to be 10^{-5} sec. compared to $1{\cdot}13 \times 10^{-7}$ and 2×10^{-6} sec. respectively for Hg and Cd. Some values have also been obtained for the $\lambda = 2139$ Å. line. F. S.

812. Structure of the Band Spectrum of Helium. Part V. W. E. Curtis and A. Harvey. *Roy. Soc., Proc.* 121. *pp.* 381–401, *Nov.* 1, 1928.

Five new He_2 bands are described: (1) a weak vibrational band associated with the known band near λ5730 (3D → 2P) of $_0He_2$; (2) the counterpart for $_pHe_2$ of the $_0He_2$ band 3X → 2P [see Abstract 1606 (1928)]; (3) to (5) bands having 2P as the final electronic level and a new level Z as initial. The level Z is rotationally single, like S and X, but the rotation terms cannot be represented by the usual type of formula, nor are the relative intensities of the branches as in other bands. The X and Z levels are additional to the ordinary atomic system of levels, and are identified tentatively with certain new types predicted by Hund for diatomic molecules, but not hitherto established by observation. W. S. S.

813. Band Spectrum of Helium. W. Weizel. *Zeits. f. Phys.* 51. 5–6. *pp.* 328–340, 1928.

A study of the conditions of activation necessary for the production of the helium band spectrum shows that the molecule which gives rise to this spectrum is formed by the union of two activated or metastable helium atoms and not from the union of an activated and a normal atom. A development is made of the Mulliken term scheme on the basis of Hund's theory of molecular spectra. Three new bands are described. F. J. W.

814. Stark Effect of Helium. Y. Ishida and G. Kamijima. *Inst. Phys. and Chem. Research, Tokyo, Sci. Papers No.* 160. *pp.* 117–140, *Sept.* 18, 1928. *In English.*

The apparatus and method were the same as previously described (see Abstract 3239 (1928)]. Photographs taken with a battery supply and with a transformer were compared and found to agree. The following lines have been photographed for the first time: λλ6631·89, 4054·8, 5043·6 of parahelium and λλ6068·77 and 4277·1 of orthohelium. λ5380·3 of parahelium was also observed with a direct-vision spectroscope. Although Foster's theory [see Abstract 929 (1928)] is not expected to hold for such large fields, the agreement with present results is found to be good. It is concluded that an electric field from an incompletely rectified source is satisfactory. F. S.

815. Uncoupling of the Electronic Orbital Angular Momenta about the Molecular Axis through the Rotation of He_2. W. Weizel. *Zeits. f. Phys.* 52. 3–4. *pp.* 175–196, 1928.

Nine new bands are described in the He_2 spectrum which are in part higher series terms of bands known already. They show marked anomalies which appear to some extent in the bands described in earlier investigations. These anomalies can be explained if it is assumed that the orbital angular momenta of the electrons become uncoupled through the rotation of the axis. On the same basis it is possible to arrange all the electron terms of the helium band spectrum. F. J. W.

816. Aluminium Spectrum in the Extreme Ultra-Violet. E. Ekefors. *Zeits. f. Phys.* 51. 7–8. *pp.* 471–480, 1928.

A newly constructed 1-metre vacuum grating spectrograph is described, built on the lines of the Bloch type. It is here used to measure lines in the Al-spectrum between 420 and 1860 Å.U. Certain lines due to AlII and AlIII are identified, and the terms 6*s*, 7*s*, 6*p* and 7*p* are calculated for AlIII. A. C. M.

817. Band Spectra of Aluminium Hydride. E. Bengtsson. *Zeits. f. Phys.* 51. 11–12. *pp.* 889–894, 1928.

New bands of aluminium hydride were found in the ultra-violet, and two at λλ2229 and 2254 are described in detail and a level-scheme given.

The electron-terms are given and the values B, J and r for the molecule. J, the moment of inertia, is $4 \cdot 38 \times 10^{-40}$, and r, the internuclear distance, is $1 \cdot 66 \times 10^{-8}$, both for the state ^1S (the final state in these bands). The bands only appear when the pressure is lower than atmospheric, although the visible bands appear at atmospheric pressure. Curious intensity effects were observed; in particular, with lengthy exposures, the series ended not with diffuse lines, but with stronger sharp lines. These are being further investigated. A. C. M.

818. Ultimate Rays of Mercury and Aluminium. A. T. Williams. *Comptes Rendus*, 187. *pp*. 761–763, *Oct*. 29, 1928.

Shows that the mercury line $\lambda = 1849 \cdot 57$ Å. should not be considered as an ultimate ray, whilst the line $\lambda = 2536 \cdot 52$ Å., which is a resonance line, most certainly should. This is directly opposite to the result given by Croze's law. Further, the doublet 1942 and 1649·8 Å. is persistent, especially the former line. The aluminium doublet 1862·90 and 1854·67 Å., previously considered as persistent lines, is shown to be easily affected by self-induction and not emitted by the arc. These lines cannot, therefore, be termed ultimate rays, but this classification should be given to the lines 1989·80 and 1670·98 Å. It is concluded that the ultimate rays for the elements in the second column of the periodic table, corresponding to those of the doublets $^2S^2P$ of neutral atoms of elements in the first column, are the doublets of ionised atoms. The doublets of the doubly ionised atoms of the third column are the persistent lines of these elements, whilst in the fourth column silicon shows in its ultimate rays a doublet of a simply ionised atom. R. C. F.

819. Spectra of Mercury at Atmospheric Pressure. W. H. Crew and L. H. Dawson. *J.O.S.A. and R.S.I.* 17. *pp*. 261–270, *Oct*., 1928.

Light from a mercury arc in quartz operating at atmospheric pressure and excited by various electrical means was photographed through a quartz spectrograph. With very high currents through the arc some thirteen lines were found to be self-reversed, two of which are spark lines. The reversal of one of these (λ1942) supports the view of Carrol, Turner and Compton that it is a member of the first doublet of the principal series of Hg^+. Lines of the diffuse series of Hg appear to be the most readily reversed. With relatively low currents through the arc the continuous spectrum appears in four discrete bands, three of which have intensity maxima lying close to the three spectral series limits: λ4580, λ3320, λ2240. A modification of Bohr's theory, which attributes bands of continuous radiation to the recombination of electrons with atomic or molecular ions, is found to agree very well with the observed facts. From theoretical considerations it is shown that a velocity distribution of the free electrons in the arc, corresponding to a temperature 2500° K., gives an intensity distribution of continuous spectrum in agreement with that observed. Certain observations by Rayleigh are found to be compatible with this theory. AUTHORS.

820. Diffuse Molecular Spectra. B. Rosen. *Zeits. f. Phys.* 52. 1–2. *pp*. 16–20, 1928.

It is shown by experiments on sulphur-vapour that the diffuse molecular bands cannot completely be accounted for by "Auger-processes" (the energy of the quanta being changed into translational energy of the component atoms flying apart), although these undoubtedly are present. There must in addition be a contributory cause: the increase in the effective cross-section due to greater amplitudes of nuclear vibration. A. C. M.

821. Spectrum of the Hydrogen Molecular Ion. C. J. Brasefield. *Nat. Acad. Sci., Proc.* 14. *pp.* 686–689, *Sept.*, 1928.

At very low pressures the particles in the canal-ray beam in hydrogen are nearly all molecular ions. Consequently by studying the light emitted by the beam it is possible to pick out groups of lines in the many-line spectrum of hydrogen due to this particular emitter. However, the light from the beam comes not only from the moving H_2^+ ions, but also contains radiation excited from the resting gas by the moving ions. But the two can be distinguished by varying the pressure. The true radiation from the moving H_2^+ ions increases in intensity to a maximum for a pressure of 0·007 mm. and thereafter decreases, while the resting-gas radiation steadily increases. In this way a group of lines was picked out; some of them can be grouped into Q branches. Three such are given; the bands degrade rapidly to the red, meaning that the initial moment of inertia is much larger than the final moment of inertia. The heads of the three bands are connected by a simple Rydberg formula:—

$$\nu = A - \frac{4R}{(m+\mu)^2}, \text{ where A is } \frac{4R}{(3\cdot 98)^2}.$$

A. C. M.

822. Lyman Bands of Hydrogen. E. C. Kemble and V. Guillemin, Jr. *Nat. Acad. Sci., Proc.* 14. *pp.* 782–787, *Oct.*, 1928.

There is some uncertainty as to the structure of the Lyman bands ($B_3 - A_n$), and the identity of the two branches observed is not definitely fixed. Hori favours the view that these are really P, Q and R branches, as in the Werner bands, but that the corresponding lines of the P and Q branches are so close to one another as to form in all cases unresolved doublets. The authors contest this view, as it seems very improbable that the P and Q lines would lie so close together as to have completely escaped resolution; they have re-examined the B-A bands to see whether an interpretation based on the two-branch hypothesis is not feasible, and although the analysis is not as yet as complete as that of Hori, it has been demonstrated that this explanation agrees with the facts. Certain peculiarities in the observed intensities of the lines are discussed. These and the small number lines may both be due to the peculiar method of excitation producing the bands by passing a discharge through a mixture of argon and hydrogen. The probable processes involved are considered in detail. H. N. A.

823. Molecular Spectrum of Hydrogen. W. Finkelnburg. *Zeits. f. Phys.* 52. 1–2. *pp.* 27–118, 1928.

The secondary hydrogen spectrum has been measured between H_β and the ultra-violet end of the spectrum (λλ4861–3314), using a concave grating (1·98 Å.U. per mm.). The error of the strong lines is estimated at 0·0035 Å.U. Judging by the intensities under different conditions of excitation, many of the lines are classified into three categories. The wave-numbers are also given, together with the measurements of Gale, Monk and Lee. A long bibliography is appended. A. C. M.

824. Decay of the Balmer Series. J. Port. *Ann. d. Physik,* 87. 4. *pp.* 581–589, *Oct.* 12, 1928.

The rate of decay of the hydrogen canal-ray spectrum follows an exponential law without any appreciable deviation in the neighbourhood of the slit. Neither the Wien deviation [see Abstract 1185 (1925)] nor the Stark decay are atomic in their origin. In opposition to the classical theory, the decay constants are independent of the wave-length in the Balmer series. J. E.

825. Light Scattering in Water. G. I. Pokrowski. *Zeits. f. Phys.* 52. 5–6. *pp.* 448–450, 1928.

The Raman effect in water shows diffuse bands. The frequency difference between these bands (maxima) and that of the exciting light corresponds to an infra-red absorption band of wave-length $3 \cdot 04\,\mu$ (maximum) and half-width $0 \cdot 54\,\mu$, which is actually found in the absorption spectrum of water. J. E.

826. Ultra-Violet Bands of the Earth Alkali Sulphide Phosphors. O. Schellenberg. *Ann. d. Physik,* 87. 5. *pp.* 677–715, *Nov.* 1, 1928.

It is found that the best conditions for the emission of the ultra-violet bands are with very small active metal content. The metals which are active in producing visible phosphorescence are also active for ultra-violet emission. The shift towards the red found by Lenard [see Abstract 810 (1910)] in progressing from Ca, Sr to Ba is also true for these ultra-violet bands. The temperature limits are recorded. At the temperature of liquid nitrogen the bands split up into narrow bands or lines. The long wave-length limit of duration excitation was found. Some new visible bands were found and examined. J. E.

827. Alkali-Halogen-Phosphors in Presence of Copper. A. M. MacMahon. *Zeits. f. Phys.* 52. 5–6. *pp.* 336–341, 1928.

This paper investigates the stability of alkali-halogen-phosphors with copper ion addition and the influence of temperature upon the shape of their absorption or excitation bands. NaCl- and KCl-phosphors with copper are unstable if the lattices are much disturbed mechanically by high copper-concentration. The excitation bands after some months exhibit pronounced flattening. The influence of cooling upon the absorption bands is, in general, similar to that found by Lorenz [see Abstract 914 (1928)] for Tl- and Pb-phosphors. Two new facts, however, have emerged: (*a*) The relatively broad bands resulting from the Cu-addition are resolved by cooling into two or three component bands; (*b*) band narrowing during cooling is not always accompanied by an increased absorption constant, although in the case of NaCl-phosphors the bands are narrower and lower. H. H. Ho.

828. Measurement of the Duration of Life of Excited Na Atoms by Means of the Brightness of Na Flames and the Degree of Dissociation of Sodium Salts in the Flame. R. Ladenburg and R. Minkowski. *Ann. d. Physik,* 87. 3. *pp.* 298–306, *Oct.* 12, 1928.

Considers the discrepancy between the results obtained by Ornstein and v. d. Held, by means of measurements of the brightness of sodium flames, and those of the authors, using measurements of magnetorotation and absorption. The difference between the calculated times during which the

Na atom remains in the 2^2P state is large, and a theoretical consideration of the conditions of Ornstein and v. d. Held's experiments leads to the conclusion that the Na salts were not completely dissociated in the flames employed, so that the number of excited atoms was less than that assumed by them. H. N. A.

829. Recombination of Argon Ions and Electrons in the Afterglow. C. Kenty. *Phys. Rev.* 32. *pp.* 624–635, *Oct.*, 1928.

The arc spectrum of argon is found to persist 0·001 sec. after an arc of 0·4 ampere in pure argon at 0·5-mm. pressure is cut off. Lines involving jumps from high energy levels are stronger in the afterglow. D-lines, if present in the arc, are absent in the afterglow. This shows that the electron speeds in the afterglow are too low to excite the argon arc spectrum by direct impact, so that the highly excited argon atoms must be produced by recombination of ions and electrons. The presence of 0·001 mm. of hydrogen does not affect the afterglow, so that the persistence of metastable atoms is not involved in the production of the after-glow. Accelerating potentials of 3–10 volts applied to the afterglow quench it. Retarding after-voltages up to 90 have no effect. The velocities of the electrons are increased in the first case, unaffected in the second (determined by a probe method). The quenching is ascribed to the decrease in the probability of recombination due to higher electron speeds. The intensity of the afterglow is directly related to the concentration of positive ions. Arc spectra are obtained under conditions unfavourable to recombination. They are, therefore, primarily excitation spectra. Intermittent discharges should be favourable to the production of lines involving high series members. Positive ion concentration is of the order of 10^{12} per c.c. The mean energy of the electrons is 0·4 volt. The coefficient of recombination is of the order of 2×10^{-12}. A. C. M.

830. Zeeman Effect of the Argon Spark Spectrum (ArII). C. J. Bakker, T. L. de Bruin and P. Zeeman. *Zeits. f. Phys.* 52. 3–4, *pp.* 299–300, 1928.

A note on a recent paper on the subject by the authors. In connection with a small deviation from the *g*-summation law in terms with $j = 1$ of the $4p$ electron, the direct measurements on the grating photographs made with a comparator have now been compared with photographs of the magnetic separations. Small observational differences are found, and it is shown that the summation law really holds with accuracy in the above case. H. N. A.

831. Wave-Lengths and Zeeman Effects in Yttrium Spectra. W. F. Meggers. *Dept. of Commerce, Bureau of Standards, Research Paper No.* 12. *pp.* 319–341, 1928.

The wave-lengths corresponding to approximately 1000 lines photographed in the arc and spark spectra of yttrium were measured relative to secondary standards in the iron spectrum. The values extend from 2127·99Å. in the ultra-violet to 9494·81Å. in the infra-red. A comparison of relative intensities and other characteristics of lines in the different sources permitted a sharp discrimination between four classes of lines; about 500 are ascribed to neutral atoms (constituting the YtI spectrum), 240 originate with singly ionised atoms (YtII spectrum), 10 belong to doubly ionised atoms (YtIII spectrum), and most of the remain-der describe the band spectrum characteristic of molecular compounds, presumably yttrium oxide. Measurements of Zeeman effects (photographed by Moore) for 220 yttrium lines ranging in wave-length from 3173Å. to 6896Å. are included. AUTHOR.

832. Tables of Theoretical Zeeman Effects. C. C. Kiess and W. F. Meggers. *Dept. of Commerce, Bureau of Standards, Research Paper No.* 23. *pp.* 641–684, 1928.

The splitting of spectrum lines into components, when the source is in a magnetic field—the Zeeman effect—furnishes theoretically an absolute identification of the terms involved in the production of the lines. Based on the theoretical work of Landé, the Zeeman effects of various term combinations have been computed, and these are now presented in tabular form. The tables give results for terms from S to I in the doublet, quartet, sextet and octet systems; in the triplet, quintet and septet systems; and in the doublet-quartet, quartet-sextet, sextet-octet, singlet-triplet, triplet-quintet and quintet-septet intersystems. AUTHORS.

833. Absorption Spectrum of Nitrogen Dioxide. L. Harris. *Nat. Acad. Sci., Proc.* 14. *pp.* 690–694, *Sept.*, 1928.

A summary of recent experimental results obtained for the absorption of light by the system $2NO_2 = N_2O_4$ in the gaseous phase and in the ultra-violet and visible region of the spectrum. The absorption spectrum of single NO_2 molecules consists of a large number of bands, many with fine structure, from 6000 Å.U. to 2250 Å.U. Absorption due to $(NO_2)_2$ in the gaseous phase is continuous. Two bands, one with a maximum at 3500 Å.U. and another with a maximum farther into the ultra-violet, merge into one continuous band at high pressures of $(NO_2)_2$. A. C. M.

834. Stark Effect of Lithium. Y. Ishida and M. Fukushima. *Inst. Phys. and Chem. Research, Tokyo, Sci. Papers No.* 161. *pp.* 141–150, *Sept.* 24, 1928. *In English.*

The requisite density of lithium vapour was produced by packing a small piece of lithium metal into a cavity in the kathode itself. The effect has been observed with the lines λλ6708·2, 6103·77, 4971·98 and 4273·3 for the first time. Some similarities of two (2*p* — *mq*] lines of lithium and orthohelium are noted. The inverse Stark effect in the case of the *p*-component of the line λ4143·7 has also been photographed. F. S.

835. Experimental Proof of the Combination Rules in Band Spectra. E. Bengtsson and E. Hulthén. *Zeits. f. Phys.* 52. 3–4. *pp.* 275–279, 1928.

The terms of a band system may be put into two non-combining partial systems [see Abstract 909 (1928)]. This is the way in which the selection principle enters into band spectra. There remains the question, however, how far this division into two systems holds when the transitions are known to be between two electron terms. Kronig has dealt with this problem from the wave mechanics viewpoint [see Abstract 3234 (1928)]. If the empirically found partial bands systems are taken as the even and odd rotation terms of an electron state, then the rule is that only even or odd terms combine together. Observations on the Al H-band spectrum have entirely confirmed the Kronig rule. J. E.

836. Absorption Spectra of the Rare Earths. L. L. Quill, P. W. Selwood and B. S. Hopkins. *Am. Chem. Soc., J.* 50. *pp.* 2929–2937, *Nov.*, 1928.

With the object of determining the conditions under which absorption spectra may be relied upon for the analysis of rare earth mixtures, absorption spectra of the solutions of praseodymium, neodymium, samarium and erbium nitrates were obtained under various conditions. The addition of nitric acid definitely affects the absorption spectra, although no generalisation can be made as to the effect of excess nitric acid. Neodymium nitrate is also similarly affected, but to a lesser degree, by hydrochloric acid, whilst adding magnesium nitrate to it produces a similar change, this being slightly greater than that produced by an equal normality of nitric acid. The bands of neodymium nitrate are affected by rare earth nitrates in a similar manner to the way in which magnesium nitrate affects them. Large deviations from Beer's law are observed for the neodymium nitrate solutions, which resemble, to a certain extent, the effect of nitric acid. Delauney's results [see Abstract 3119 (1927)] were not confirmed by this work, and generally it was found that the absorption spectra of solutions of the rare earth salts are not suitable for quantitative estimation in the presence of one another. R. C. F.

837. Hyperfine Structure in the Arc Spectrum of Cæsium and Nuclear Rotation. D. A. Jackson. *Roy. Soc., Proc.* 121. *pp.* 432–447, *Nov.* 1, 1928.

Investigation of lines of the principal series of the arc spectrum of cæsium in search of hyperfine structure due to nuclear spin. Details are given of the most suitable method of exciting the spectrum. (Tube containing helium under 2-mm. pressure, low concentration of cæsium vapour, excitation through external electrodes by an oscillator of frequency 10^7 sec.$^{-1}$. Low vapour pressure is essential for separation of hyperfine structure components.) The lines of the principal series are found to consist of close doublets, with nearly constant wave-number separation (about 0·3 cm.$^{-1}$), which can be explained by assuming a nuclear spin of one half-quantum. The analysis is in very satisfactory agreement with the work of Back and Goudsmid on the hyperfine structure of the bismuth lines [see Abstract 1289 (1928)]. A selection principle is found which applies both to the bismuth and cæsium spectra. H. R. R.

838. Metals Fe, Co, Ni, Cu used as Diffraction Gratings for X-Rays. S. Pastorello. *N. Cimento*, 5. *pp.* 284–289, *July*, 1928.

An investigation was made of the behaviour of the elements of atomic number 26 to 29, and such of their diffraction networks as could be used for the corresponding radiations Kα and Kβ, and their characteristics so manifested, *viz.*, Fe, cubic body-centred with anti-kathodes of Fe, Co, Ni, Cu; Co, cubic face-centred; Ni, the same; and Cu, the same, still with the same anti-kathodes. The ratio of the intensity Kα/Kβ was established by microphotometry, when the diffuse radiation is contained between limits such as permit of measurements being made. J. J. S.

839. X-Ray Photogoniometer. J. D. Bernal. *Journ. Sci. Instruments*, 5. *pp.* 241–250, *Aug.*, *and pp.* 281–290, *Sept.*, 1928.

In continuation of a former paper [see Abstract 2452 (1927)], an instrument manufactured by W. G. Pye & Co. is described and the following topics connected with its design are discussed: Breadth and divergence and axis of the incident X-ray beam; best size and shape of crystal to get the maximum resolution; influence of aperture and crystal on the shape of the spots on the rotation photograph; intensity considerations; rotating spindle and crystal-holder; camera for X-ray plates or films. W. H. GE.

840. Thermal Degeneration of the X-Ray Haloes in Liquids and Amorphous Solids. S. S. Ramasubramanyam. *Indian Journ. Phys.* 3. *pp.* 137–149, *Sept.* 30, 1928.

X-ray diffraction in a number of liquids—*viz.*, cyclohexane, pentane and glycerine—as well as that of an amorphous body (a synthetic hydrocarbon resin) at different temperatures has been studied. As predicted by Raman and Ramanathan in 1923, three definite effects were observed on raising the temperature: (1) Visible contraction of the ring; (2) broadening of the ring and diffuseness of the edges; (3) a large amount of internal scattering. It is pointed out that the first effect is due to thermal expansion of the liquid, since the distance between the molecules is increased thereby. The second effect is due to increased displacements of the molecules from their mean positions. The third effect is explained as due to local fluctuations of density of scattering electrons arising from the varying positions and orientations of the molecules within the liquid. On raising the temperature, the compressibility increases, and the fluctuations of electron density become larger and hence give rise to increased scattering at small angles. In the case of spherical or nearly spherical molecules this effect is limited, whereas in the case of long chain compounds it reaches its maximum. The case of the amorphous solid is similar to that of the liquid, once it passes the transition interval, and melts completely, in conformity with the expectation of Raman and Ramanathan. W. V. M.

841. Output per Quantum for the Action of X-Rays on Silver Bromide. J. Eggert and W. Noddack. *Zeits. f. Phys.* 51. 11–12. *pp.* 796–804, 1928.

The measurements recorded in a previous paper [see Abstract 2918 (1927)] are extended to other kinds of emulsion. The previous result is confirmed, and a contradiction between the authors' results and those of March is investigated. H. N. A.

842. Ultra-Violet Luminescence Excited by X-Rays in CaS and CaO. E. Rumpf. *Ann. d. Physik,* 87. 4. *pp.* 590–594, *Oct.* 12, 1928.

This luminescence is probably due to unremovable impurities. Addition of Cu or Mn gave new bands. The wave-length of the CaO bands is some 100 Å. shorter than that of the CaS band. J. E.

843. X-Ray Phosphorescent and Thermo-Phosphorescent Radiations of Kunzite. O. Stuhlman, Jr., and A. F. Daniel. *J.O.S.A. and R.S.I.* 17. *pp.* 289–293, *Oct.*, 1928.

The colour of the phosphorescent light under X-rays is similar to that under kathode rays and radium excitation. Samples of kunzite were exposed to unfiltered radiations from a tungsten target. Visual examination separated the fluorescent spectrum into an orange-red band and a faint blue-green band. Long exposure to the X-rays produced phosphorescence confined to the visible region. Spectrographic examination showed that the spectrum is practically identical with the kathodo-luminescent spectrum discovered by Nichols and Howes [see Abstract 1684 (1914)]. The thermo-phosphorescence temperature limits are from 168° C. to 400° C. Visual examination showed two broad bands with maxima at about 0·64μ and 0·50μ. Heating destroys the colour produced by X-rays, and renewed exposure produces a series of colours and, finally, transparency. The colour changes are suggested as being due to oxidations in the solid solution, which contains $KMnO_4$ as the possible oxidising agent, the various oxides of manganese accounting in quantity and nature for the succession of the colour changes. J. E.

844. Quantitative Study of the Reflection of X-Rays by Sylvine.

R. W. James and G. W. Brindley. *Roy. Soc., Proc.* 121. *pp.* 155–171, *Nov.* 1, 1928.

Observations were made at absolute temperatures ranging from 86° to 936°, using the spectra (400), (600) and (800). The values of $(\lambda/\sin\theta)^2 \log(\rho_T/\rho_{290})$ are plotted against the temperatures, and the agreement between theory and experiment is very good up to about 400° abs., the graph being a straight line; above this the decrease of intensity with temperature is more rapid than the theoretical. For the lower temperatures $\Delta M/(h^2 + k^2 + l^2)$ should theoretically be constant for all temperatures, and this is practically so experimentally, and the mean value agrees well with that calculated from the values of $\phi(x)/x$ given by Debye. The agreement is closer than in the case of rock-salt, and this is partly due to the fact that the K and Cl atoms are nearly equal in mass, so that it is possible to treat the lattice as simple cubic, while in rock-salt the atoms differ both in size and mass. Theory and experiment are also compared, using the elastic constant, and fairly close agreement is obtained. Assuming the existence of zero-point energy, the calculated value of the mean square amplitudes of vibration of the atoms of the lattice are 0·255 Å. at 290° and 0·149 Å. at 86°. The values of $(F_K + F_{Cl})e^{-M}$ are calculated for the different spectra, with no zero-point energy and with zero-point energy, and the results compared with the observed values; for large values of $\sin\theta/\lambda$ the latter agree well with the existence of zero-point energy. The correction for extinction is considered. H. N. A.

845. Anomalous Dispersion in X-Ray Regions of the Spectrum.

R. Forster. *Helv. Phys. Acta,* 1. 1. *pp.* 18–46, 1928. *In German.*

Detailed investigation of the refractive indices of a number of substances for homogeneous X-radiations of wave-lengths between 0·5 and 2·3 Å.U. The homogeneous radiations are sorted out by the X-ray spectrometer and the refractive indices deduced from the limiting angles of total reflection. The radiations used were silver K with some intermediate metals down to chromium K, and platinum and iridium L rays (Hadding tube with interchangeable anti-kathodes). The reflecting surfaces were magnalium, glass, and silver and copper sputtered on glass. Writing $n = 1 - \delta$, it is found that δ increases, in accordance with the classical dispersion formula, regularly with the square of the wave-length. The reflection from copper is of special interest, as the K-absorption edge of copper falls within the region investigated. It is found in this case that the classical relation holds right up to the absorption edge, on each side; n is, however, slightly greater on the short-wave side than on the long-wave side of the absorption discontinuity. If the transition through the values $\pm\infty$ demanded by the

Lorentz theory at the discontinuity, or if n is $-\infty$ on both sides of the discontinuity, as suggested by the theory of Kallmann and Mark [see Abstract 2303 (1927)], the changes must occur in a range of wave-lengths which is too small to be investigated in these experiments. It is suggested that there is a simple discontinuity in the refractive index at the absorption edge. The experiments are decisively against any type of anomalous dispersion predicted by existing theories. H. R. R.

846. Polarisation of Characteristic X-Rays. H. Mark and K. Wolf. *Zeits. f. Phys.* 52. 1–2. *pp.* 1–7, 1928.

Using a photographic method, it is shown that the possible degree of polarisation of copper K-radiation lies within the limit of experimental error, *i.e.*, less than 1 %. **Errata,** *ibid.*, 52. 7–8. *p.* 600, 1928. A. C. M.

847. Intensity Distribution of the General and Characteristic X-Radiation from Molybdenum. L. R. G. Treloar. *Phil. Mag.* 6. *pp.* 1008–1019, *Nov.*, 1928.

Measurements are given of the complete radiation emitted under working conditions from a Shearer tube fitted with a molybdenum target, including (1) the intensity distribution of the general radiation at various voltages, (2) the corresponding intensities of the $K\alpha$- and $K\beta$-line radiation, and (3) the ratio of the homogeneous to the general radiation. Both coil and interrupter and transformer methods of excitation were employed. The ratio of the α-line and β-line intensities was found to be approximately 4·0, and the ratio $(\alpha + \beta)$/total, of the order 30 %, both methods of excitation giving practically the same results. The method of excitation appears to have no marked effect on the intensity distribution. W. S. S.

848. Intensities of K X-Rays from Thin Targets. D. L. Webster, H. Clark, R. M. Yeatman and W. W. Hansen. *Nat. Acad. Sci., Proc.* 14. *pp.* 679–686, *Sept.*, 1928.

The paper is a preliminary report on a study of the probability that a kathode ray of known energy invading an atom of silver will remove a K electron from it. Targets have been used so thin that no appreciable retardation of the kathode rays is caused. The data give the relative intensity of K-series X-rays, and, therefore, the relative probability of direct K-electron ionisation as a function of kathode-ray energy. The range is from the excitation energy up to energy 3·3 times as great. None of the three theories available is in exact agreement with these results, but an empirical equation is given which satisfies them. A. C. M.

849. Continuous X-Radiation of Thin Aluminium Foils. H. Kulenkampff. *Ann. d. Physik.* 87. 5. *pp.* 597–637, *Nov.* 1, 1928.

Thin sheets were used in place of the massive anti-kathodes commonly worked with, in order to avoid loss of velocity, and diffusion of the kathode rays. The emitted intensities were too small for spectrometer analysis and an absorption method had to be employed. The following aspects of the radiation were investigated: (1) Change in the spectral distribution for different azimuths (angle between advancing kathode beam and X-ray emission direction); (2) variation in intensity of X-rays of a given small wave-length band, with increase in the velocity of kathode rays (fixed azimuth); (3) azimuthal intensity distribution for different small wave-length bands and for different kathode-ray velocities. The emission is found to differ in a number of respects from that given by a massive anti-kathode. W. S. S.

850. Precision Measurements in the K-Series of the Elements 30 Zn to 44 Ru. B. Edlén. *Zeits f. Phys.* 52. 5–6. *pp.* 364–371, 1928.

This paper records measurements of the K-lines α_2, α_1, β_3, β_1, and β_2 of the elements Mn, As, Se, Br, Rb, Sr, Y, Zr, Nb, and Ru (except Naβ_3, Asβ_3, Seβ_3, and Brβ_3) to the first order by means of the precision-spectrometer of Siegbahn and Larsson [see Abstract 2547 (1927)] H. H. Ho.

851. Absolute Measurements of X-Ray Intensities. M. Steenbeck. *Ann. d. Physik*, 87.6. *pp.* 811–849, *Nov.* 22, 1928.

A determination of the energy (ϵ) expended per pair of ions produced in air by soft X-radiation (Cu and CrKα, rendered approximately homogeneous by the standard filtration method). The number of quanta of X-radiation absorbed per unit path is measured by a double Geiger counter, with photographic registration, the (narrow) X-ray beam passing through an electric field which sweeps ions from a well-defined element of the beam into the two counting chambers. At the same time the ionisation current is measured between two plates situated at another part of the beam. Within experimental error, ϵ is sensibly the same for CuKα and CrKα rays and $= 28 \pm 6$ electron-volts per pair of ions. This is in agreement with most of the recent determinations of ϵ for harder X-rays, but very appreciably lower than Lehmann and Osgood's values for very slow electrons [see Abstract 3179 (1927)]. The original should be consulted for the very complete details of the measurements. H. R. R.

852. Intensity and Quantum Theory. F. Sauter. *Zeits. f. Phys.* 52. 3–4. *pp.* 225–234, 1928.

A formula is sought for the distribution of intensity in Compton's scattering. With the aid of subsidiary assumptions that the electron and the quantum behave to one another as perfectly elastic and perfectly smooth balls, a formula is arrived at which satisfactorily agrees with experiment. A. D.

853. Number of "Recoil" Electrons and the Intensity of Modified Scattering. E. J. Williams. *Manchester Phil. Soc., Mem.* 72. *pp.* 1–16, 1927–1928.

The secondary β-rays produced by X-rays are of two types, long-range photoelectrons and short-range "recoil" or R electrons. If N_R is the number of the latter and N_P that of the former, N_R/N_P varies as, and is nearly equal to, σ/τ, where σ is the scattering coefficient and τ the photoelectric absorption coefficient. According to the quantum theory, the recoil electrons are caused by the scattering of "modified" radiation of a slightly different wave-length than the primary X-radiation, and $N_R/N_P = \sigma_m/\tau$, where σ_m is the scattering coefficient of the modified radiation. σ_m is estimated for oxygen and nitrogen from experimental results for carbon and aluminium. The value agrees with that found by Nuttall and Williams for $\tau N_R/M_P$ with O and N. This shows that the number of recoil electrons is equal to the number of modified quanta scattered. Theoretical values of σ_m obtained by means of wave mechanics differ from the values of $\tau N_R/N_P$ on the average by 15 %, which is within the limits of experimental error. In the case of carbon, the theoretical and observational values of the ratio between the modified and unmodified scattering show rather more serious differences. H. N. A.

854. Raman Effect in X-Rays. M. Ponte and Y. Rocard. *Comptes Rendus*, 187. *pp*. 828–829, *Nov*. 5, 1928.

In the Raman effect the greater the frequency the more the phenomenon appears to abandon the classical theory and to submit, in the region of the X-rays, to a theory of quanta of light. A. D.

855. Reflection of Soft X-Rays. J. E. Henderson and Elizabeth R. Laird. *Nat. Acad. Sci., Proc*. 14. *pp*. 773–777, *Oct*., 1928.

A brief preliminary account of experiments on the specular reflection of soft X-rays at polished iron and glass surfaces. The X-rays are produced in a tube with nickel anti-kathode, and excited by kathode rays of energies of 190–4000 electron-volts. The intensity of the reflected beam is measured by the photoelectric emission of a receiving plate. With the very soft rays there is no sharply defined range of angles at which total reflection occurs [see Thibaud, Abstract 3047 (1928)]. This difference between the reflections of hard and soft rays is satisfactorily explained by the high absorbability of the latter. H. R. R.

856. Soft X-Ray Levels of Iron, Cobalt, Nickel and Copper. O. W. Richardson and F. C. Chalklin. *Roy. Soc., Proc*. 121. *pp*. 218–236, *Nov*. 1, 1928.

A continuation of a previous paper, in which a number of discontinuities in the excitation of soft X-rays by the photoelectric method were explained by transitions from two levels not far from the M_I and $M_{II\,III}$ levels (spoken of as X_1 and X_2 in the present paper) to a series of virtual levels b/n^2 [see Abstract 2410 (1928)]. Further levels, X_3 and X_0, are shown to exist, though X_0 is doubtful in the case of copper. There is also for each metal an L level involved. The following table shows the relation between these levels, the values being in volts:—

	Fe.	Co.	Ni.	Cu.
L	790	860	934·7	1018·9
X_0	292	375	409	(420)
X_1	180	179·5	181·9	185
X_2	151·8	150·5	152·6	156·1
X_3	99·5	100·5	102·8	103·8
$X_1 - X_3$	80·5	79	79·1	81·7
$M_I - M_{IV\,V}$ from X-ray data	88·65	96·1	103·9	114·9
Difference	8·15	17·1	24·8	33·2

When $\sqrt{\text{volts}}$ is plotted against atomic number the L levels fall accurately on a straight line; the X_1, X_2 and X_3 levels are practically the same for each element; the X_0 level shows a variation which is very similar to the shape of the Moseley diagrams of the L and M levels when they are being completed. The differences between the values of $M_I - M_{IV\,V}$ given by X-ray emission data and of $X_1 - X_3$ seem very systematic, the successive differences being almost exactly in the ratio 1 : 2 : 3 : 4. The X-ray data apply to an atom in which an electron is missing from the L level, while this level is filled when X_1 and X_3 are determined; the exact relation between the new levels and the X-ray emission levels remains uncertain. There are important differences between copper and the other three metals. Some theoretical suggestions are made. H. N. A.

857. Separation and Purification of Radium D, Radium E and Polonium (Radium F). O. Erbacher and K. Philipp. *Zeits. f. Phys.* 51. 5–6. *pp.* 309–320, 1928.

A method was used in which the impure RaD was treated electrolytically in two stages. In the first a current of $3 \cdot 10^{-3}$ ampere was employed and 26 % of the RaD was deposited on the anode and 67 % on the kathode in a fairly pure state; this was then dissolved in H_2NO_3 and electrolysed with a current of only $3 \cdot 10^{-4}$ ampere. The RaD, apparently with the RaE and RaF, was now all deposited on the anode in a state of purity, and a very large proportion of the amount started with was obtained. Polonium was separated from the RaD solution by the old method of electrochemical separation on silver, and finally RaE was removed by electrochemical deposition on nickel. The RaD left was purified from dissolved silver and nickel using the electrolytical process with $3 \cdot 10^{-4}$ ampere, though even then some RaE was found in it, which had been formed by disintegration in the interval since this substance had been removed.

H. N. A.

RADIOACTIVITY.

858. Transfer of Energy in Nuclear Collisions. W. Kuhn. *Zeits. f. Phys.* 52. 3–4. *pp.* 151–157, 1928.

The stabilities of atomic nuclei are often estimated in terms of the minimum energies of (say) the α-particles which are competent to disrupt them by collision. These are of the order 10^{-5} erg. Detailed consideration of the mechanism of a collision shows that, in general, only a small fraction of the energy of the impinging α-particle is communicated to the inner structure of the struck nucleus. It is deduced from this that a nucleus can become unstable through an accession of only 10^{-7} erg to the energy of its inner degrees of freedom. This estimate of nuclear stability leads to new views on the conditions under which disintegration is likely to occur. In particular it is shown that atomic disintegration may be expected under the conditions prevalent in the fixed stars. H. R. R.

859. Rate of Emission of α-Particles from Radium. H. J. J. Braddick and H. M. Cave. *Roy. Soc., Proc.* 121. *pp.* 367–380, *Nov.* 1, 1928.

The paper includes an historical and critical account of previous determinations. The authors measure the total charge carried by the α-particles (using a modified Rutherford and Geiger apparatus), and obtain the number of particles by assuming Millikan's value for the electronic charge. Their final corrected result is $(3 \cdot 68 \pm 0 \cdot 04) \times 10^{10}$ α-particles per gramme of radium per second, which is in good agreement with the value which can be calculated from the heating effect of the α-particles. It is concluded that there is no evidence of any unrecognised heat-producing mechanism in radioactive disintegrations. H. R. R.

860. Loss of Velocity of α-Rays in Traversing Metal Foils. S. Rosenblum. *Phys. Zeits.* 29. *pp.* 737–739, *Nov.* 1, 1928.

From his previous results (obtained at the Institute du Radium, Paris) the author derives an expression for *d*E/*d*X, where E is the energy of the rays and X is the weight of the foil passed through in mg./cm.^{2}. From this he constructs a curve for the energy loss as a function of V/V_0, where V_0 is the original velocity of the rays and V the velocity after passing through the foil; this is compared with Bragg's ionisation curve. Values are given for the author's constant K, as calculated from the theory and as observed; they are of the same order of magnitude, but the agreement is better for low atomic numbers than for higher ones. The paper concludes with some remarks on the probable properties of uncharged, swiftly moving particles, the suggested neutrons of Rutherford, having about the same mass as a hydrogen atom with a much smaller volume. H. N. A.

861. Variations in the Ionisation Effect due to Single α-Rays. A. Piccard and E. Stahel. *Helv. Phys. Acta*, 1. 6. *pp.* 437–440, 1928. *In German.*

Investigates a number of causes which may produce variations in the amount of ionisation. These include chance encounters of two or more α-rays, deviations of α-rays through large angles, " absorption " of α-rays by nuclei with which they collide, variations which take place when the α-ray and the electric field are not parallel, changes in the charge of the α-ray during its course. None of these causes is capable of explaining the variations observed by Greinacher and by Ramelet. Hoffmann obtains quite different results from those of these experimenters.

H. N. A.

862. Luminescence Excited by α-Rays and its Relation to the Energy of the α-Particles. Berta Karlik and Elisabeth Kara-Michailova. *Akad. Wiss. Wien, Ber.* 137. 2*a*. *No.* 7. *pp.* 363–380, 1928.

Describes a method of measuring the luminescence produced in different substances by the α-rays of polonium, by means of the photoelectric current of a rubidium cell. With zinc sulphide the intensity of the luminescence is proportional to the number of α-particles at least up to $2\cdot7 \times 10^5$ particles per sec. per mm.^{2}. It is possible in this way to measure easily the strength of preparations up to 12,000 e.s.u. and more. For well-scintillating ZnSCu phospors the brightness of the luminescence was proportional to the energy given up by the α-rays; the optical absorption of the light from the scintillations plays a small but distinct part in the phenomenon. For badly scintillating specimens of zinc sulphide the α-luminescence is proportional to the residual range of the radiation; two pieces of diamond showed the same behaviour. The results agree with those recently obtained in observations of individual scintillations, and the conclusions then drawn as to the nature of the process are confirmed. H. N. A.

863. Starting Voltage of the Geiger Point Counter. O. Klemperer. *Zeits. f. Phys.* 51. 5–6. *pp.* 341–349, 1928.

Geiger and the author have recently shown that, with a small positive potential of the counter case, the discharge per α-particle is less than 10^{-13} ampere-second, and that when the potential rises there is a sudden increase for a definite potential value to 10^{-10} up to 10^{-11} ampere-second. The author considers the theory of this sudden increase, and finds that the starting voltage depends on only two constants: the number of positive ions which are required to liberate an electron from the metal surface of the "point" (small sphere) and the range of the electron. The electron is accelerated towards the walls of the chamber, produces new ions by collisions with the gas molecules, and a rush of current takes place if the number of these ions is at least equal to that of the ions primarily produced in the gas by the α-particle. A formula is derived for the starting voltage; measurements are made of its value in air, CO_2 and H_2 at different pressures; graphs are constructed to show the relation between the starting voltage, the pressure and the radius of the metal sphere; and it is shown that for the pressures commonly employed the experimental results agree well with the theoretical. H. N. A.

864. Radioactivity of Wines. A. Nodon and G. Cuvier. *Comptes Rendus*, 187. *pp.* 725–727, *Oct.* 22, 1928.

Measurements were made with the Nodon electrometer [see Abstract 1595 (1926)]. The amount of radioactivity is of the same order as for certain thermal waters. The white wines show a considerably greater activity and bigger annual variation than the red wines. The activity varies with the dry extract and reducing sugar and inversely as the alcoholic content. F. S.

865. New Investigations of the Penetrating Radiation of Hess. W. Kolhörster. *Zeits. f. Phys.* 51. 11–12. *pp.* 899–900, 1928.

Calls attention to differences between the author's views and those of Steinke [see Abstract 2413 (1928)], and upholds the former position. H. N. A.

866. Internal Conversion of γ-Rays. Bertha Swirles. *Roy. Soc., Proc.* 121. *pp.* 447–456, *Nov.* 1, 1928.

According to the experimental results of Ellis and Wooster for internal conversion of γ-rays of wave-lengths in a range $0 \cdot 03 < \lambda/\lambda_\kappa < 0 \cdot 5$ the absorption coefficient $a_{\nu\kappa}$ varies with λ to a power of about 3, and the ratio of the L_I to the K X-ray absorption is about 1/5, and the absorption in the L_I levels is greater than that in the L_{II} and L_{III} levels. From the author's mathematical calculations it appears that, theoretically, the K absorption coefficient varies with λ to a power not widely differing from 3 in the limiting cases considered and that $a_{\nu\kappa}$ varies with λ to a power between 2 and 3 but is of the order of 1/10 too small. The absorption in the L_I levels is 1/8 of that in the K levels, and the L_{II} and L_{III} absorption is much smaller than the L_I absorption for small wave-lengths. With regard to the variation of a_ν with λ and the ratio of the absorption in the K and L_I levels and in the different L levels the theory agrees fairly well with experiment. Considering Oppenheimer's results for the photoelectric effect, the theory indicates only slight variation in the ratio between internal and external absorption over a wide range of wave-lengths, in agreement with experiment. But the order of magnitude of the theoretical internal absorption coefficient is everywhere of the order 1/10 too small. [See Abstract 381 (1928).] J. J. S.

HEAT.

867. Unit of Thermal Resistance: the "Fourier." D. R. Harper. *Washington Acad. Sci., J.* 18. *pp.* 469–475, *Oct.* 19, 1928.

The proposal is advanced to assign to the practical metric unit of thermal resistance the name "Fourier," in honour of the foremost contributor to the theory of thermal conduction. The absolute unit of energy, the erg, being too small for many purposes, the joule is regarded by the author as the practical metric unit of energy, and the watt for rate of energy transfer. Accordingly the "Fourier" is defined as that thermal resistance which will transfer heat energy at the rate of 1 joule per second (1 watt) for each degree (Centigrade) of temperature difference between its terminal surfaces. The "laboratory Fourier" may be visualised as a prism of silver or copper about 4 cm. long and 1 cm.^{2} cross-section. The paper outlines briefly the psychological reasons for naming some elementary units in each branch of physics, and discusses various possible selections of metric and English units for heat transfer problems. Two tables are given: the one is the author's estimate of the most suitable values to use for thermal resistivities of about 30 common materials; the other is a conversion table between 9 of the units of heat transfer per unit area, common in the literature of to-day. AUTHOR.

868. Thermal Expansion of Magnesium and Some of its Alloys. P. Hidnert and W. T. Sweeney. *Dept. of Commerce, Bureau of Standards, Research Paper No.* 29. *pp.* 772–792, 1928.

The linear thermal expansion of six samples of cast and extruded magnesium and eleven samples of cast and extruded magnesium-aluminium and magnesium-aluminium-manganese alloys was investigated by three methods, *viz.*, (*a*) precision comparator, (*b*) interferometer, and (*c*) the fused quartz tube described in the present paper. The magnesium samples were examined over various temperature-ranges between − 183° and + 500° C. and the alloys between room-temperature and 500° C. The following equations are quoted as probable second degree equations for the expansions between room-temperature and 500° C.:—

Cast magnesium:

$$L_t = L_0[1 + (24\cdot94t + 0\cdot00946t^2) \times 10^{-6}] \ldots\ldots\ldots \quad (1)$$

Extruded magnesium:

$$L_t = L_0[1 + (24\cdot66t + 0\cdot00976t^2) \times 10^{-6}] \ldots\ldots\ldots \quad (2)$$

Average of (1) and (2):

$$L_t = L_0[1 + 24\cdot80t + 0\cdot00961t^2) \times 10^{-6}].$$

Cast magnesium has a slightly higher coefficient than extruded magnesium, as is also found in the case of the alloys. There is good agreement with previous observers, whose work is comprehensively reviewed, and the present determinations. The addition of 0 to 10 % of aluminium to alloys with magnesium causes practically no change in the coefficients of expansion. The magnesium-aluminium alloy (10 % Al), extruded and heat treated, showed critical regions above 200° C. Small additions of manganese (0·9 and 0·3 %) to magnesium and Mg-Al alloys caused slight changes in the thermal expansion coefficients. The values found are summarised below:—

Material.	Per cent.	Average Coefficients of Expansion × 10^{-6} per °C.				
	Mg Content.	20° to 100° C.	20° to 200° C.	20° to 300° C.	20° to 400° C.	20° to 500° C.
Magnesium	99·99	26·0	26·9	27·9	28·8	29·8
Magnesium-aluminium alloys	90–96	25·4–26·4	26·1–27·8	27·7–28·1		
Magnesium-aluminium-manganese alloys ..	96–99	25·6–26·6	26·4–27·3	27·2–28·1		

S. G. B.

869. International Temperature Scale. G. K. Burgess. *Dept. of Commerce, Bureau of Standards, Research Paper No. 22. pp.* 635–640, 1928.

The full text of the agreement arrived at by 31 countries concerning the adoption of an international temperature scale, the definition of which is firstly given. Temperatures are to be designated by "°C.," but also "°C.(Int.)" may be used. The scale conforms as closely to the thermodynamic scale as possible. The basic points are: (*a*) Temperature of equilibrium between liquid and gaseous oxygen at the pressure of one standard atmosphere (oxygen point), − 182°·97 C.; (*b*) temperature of equilibrium between ice and air-saturated water at normal atmospheric pressure (ice point), 0°·00 C.; (*c*) temperature of equilibrium between liquid water and its vapour at pressure of one standard atmosphere (steam point), 100°·00 C.; (*d*) temperature of equilibrium between liquid sulphur and its vapour at the pressure of one standard atmosphere (sulphur point), 444°·60 C.; (*e*) temperature of equilibrium between solid silver and liquid silver at normal atmosphere pressure (silver point), 960°·50 C.; (*f*) temperature of equilibrium between solid gold and liquid gold at normal atmospheric pressure (gold point), 1063°·00 C. Standard atmospheric pressure is defined as the pressure due to a column of mercury 760 mm. high, having a mass of 13·5951 grammes per c.c., subject to a gravitational acceleration of 980·665 cm./sec.^{2}, and is equal to 1,013,250 dynes/cm.^{2}. The means available for interpolation divide the scale into four parts: (1) From the ice point to 660° C. the temperature is deduced from the resistance R_t of a standard platinum resistance thermometer by means of the formula $R_t = R_0(1 + At + Bt^2)$. The constants R_0, A and B to be determined by calibration at ice, steam, and sulphur points respectively. The ratio R_t/R_0 not to be less than 1·390 for t = 100° C. and 2·645 for t = 444°·6 C. (2) From − 190° C. to the ice point the temperature t to be deduced from the resistance R_t of a standard platinum resistance thermometer by means of the formula

$$R_t = R_0\,(1 + At + Bt^2 + C(t - 100)\,t^3).$$

C is determined at the oxygen point. (3) From 660° C. to the gold point the temperature t shall be deduced from the e.m.f. (e) of a standard platinum-rhodium thermocouple, one junction of which is kept at a constant temperature of 0° C., while the other is at the temperature t, to be defined by the formula $e = a + bt + ct^2$. (4) Above the gold point the temperature t is determined by the ratio of the intensity J_2 of monochromatic visible radiation of wave-length λ cm., emitted by a black body at the temperature t_2, to the intensity J_1 of radiation of the same wave-length, emitted by a black body at the gold point, by means of the formula

$$\log_e J_2/J_1 = C_2/\lambda \left[\frac{1}{1336} - \frac{1}{(t+273)}\right].$$

C_2 is taken as 1·432 cm./degrees. The equation is valid for values of $\lambda(t + 273)$ of less than 0·3 cm./degrees. Full recommendations are given, together with instructions for experimental procedure, as well as tables of secondary points. The whole note is precise and comprehensive. S. G. B.

870. Existence of an Upper Limit of Temperature and a New Radiation Formula. S. Suzuki. *Phys. Math. Soc. Japan, Proc.* 10. *pp.* 175–179, *Sept.*, 1928. *In English.*

Assumes that energy density has an upper limit, which is equivalent to saying that temperature has an upper limit. This is reached when all the atoms become free electrons and nuclei without attached electrons. If the pressure is high enough, a mass will be obtained consisting of protons and electrons without interstices, which is practically an immense nucleus and cannot be compressed farther, cannot admit light quanta, and cannot increase its energy. The idea is worked out mathematically, and a corrected form of Planck's radiation formula is obtained. H. N. A.

871. Physical Properties of Caoutchouc. M. Ruhemann and F. Simon. *Zeits. f. phys. Chem.* 138. 1–2. *pp.* 1–20, *Oct.*, 1928.

Reference is made to Tammann's work on the relationship between supercooled liquids and amorphous solids and to Simon's work on the specific heat of supercooled glycerine, the anomalous result found here having a connection with the analogous anomaly found in the dielectric constant investigation of Dewar and Fleming. The authors point out that because many experimenters have suggested that rubber consists—at least in part—of amorphous substances, they have, therefore, applied the specific heat method developed for glycerine to rubber and in addition have determined other physical constants, such as a series of coefficients of expansion dilatometrically determined and Röntgen-ray values according to Debye-Scherrer. Accordingly the specific heat for rubber of various kinds is given between − 100° and + 35° and compared with the volume expansions and Röntgen-ray interference diagrams, three anomalies being found, one pointing, in view of the earlier work of glycerine, to the solid phase of rubber being amorphous, the second anomaly having several possible interpretations, and the third being connected with the latent heat of fusion of "frozen" caoutchouc. J. K.

872. Heat Capacity at Low Temperatures of Zinc Oxide and of Cadmium Oxide. R. W. Millar. *Am. Chem. Soc., J.* 50. *pp.* 2653–2656, *Oct.*, 1928.

Research on the heat capacities of the oxides of metals previously reported [see Abstract 2759 (1928)] has been continued, the heat capacities of zinc and cadmium having been determined from 70° to 300° Kelvin. The entropy of zinc oxide at 298° K. is 10·28 ± 0·05 cal./mole/degree, whilst the entropy of cadmium oxide is 13·17 ± 0·1 cal./mole/degree. For zinc oxide the author, from an accurate value of the free energy and the entropy of formation, finds $\Delta H = -83{,}130 \pm 100$, whilst for cadmium oxide, from the entropy of formation and a somewhat uncertain value of the heat of formation, $\Delta F^{\circ}_{298} = -54{,}200$. H. H. Ho.

873. Application of the Rule of Dulong and Petit to Molecules. D. H. Andrews and E. Haworth. *Am. Chem. Soc., J.* 50. *pp.* 2998–3002, *Nov.*, 1928.

Measurements were made of the heat capacities of mono-, di-, tetra- and hexachlorbenzene, and of mono- and dibrombenzene. The heat capacity per halogen atom in these compounds approached the Dulong and Petit value of 6 cal. per degree at room-temperature, in a way which could be predicted from optically observed frequencies in the infra-red. The strength of the carbon-halogen bond in every case seemed to be about the same. F. J. B.

874. Surface Energy and Heat of Solution of Sodium Chloride. Part III. Finely-Ground Sodium Chloride. S. G. Lipsett, F. M. G. Johnson and O. Maass. *Am. Chem. Soc., J.* 50. *pp.* 2700–2703, *Oct.*, 1928.

In a previous paper [see Abstract 3153 (1927)] the authors found that the negative heat of solution of solid sodium chloride was greater than that of the finely-divided salt; the fine division had been obtained by sublimation of the salt. In the new experiments the salt is mechanically ground in an agate mortar and then placed at the bottom of a cylinder, 1 m. high, into which air is passed so as to leave through a fine nozzle at the bottom of the tube. For salt particles of about 1·3 μ diameter the heat of solution at 25° is found to be about − 900 cal. per mole against − 928·6 cal. for coarsely-ground salt. This difference is considerably greater than for the sublimed salt (where the difference was 11 cal.), possibly because the grinding produced more uneven surfaces, the sublimed salt particles being cubical. H. B.

875. Heat of Adsorption of Oxygen on Charcoal. D. McKie. *Chem. Soc., J. pp.* 2870–2889, *Nov.*, 1928.

An attempt is described to refine the method of Blench and Garner [Pt. I., *J. Chem. Soc.* 125. *p.* 1288, 1924] for determining the heat of absorption of oxygen on charcoal under various conditions of temperature and pressure, and to extend it to the general case of the measurement of the heat of adsorption of a gas on a solid surface. The present paper deals mainly with one case, *viz.*, that of oxygen adsorption on charcoal. The original paper should be consulted for a description of the specially devised apparatus and furnace used in the investigation. The mean molar heat of absorption of oxygen on charcoal at room-temperature was found to be 70 calories, this value varying somewhat according to the temperature of "activation" of the charcoal. A. B. W.

876. Freezing Point-Solubility Relations of Geometrical Isomers. Part I. The β-Chlorocrotonic Acids. E. L. Skau and B. Saxton. *Am. Chem. Soc., J.* 50. *pp.* 2693–2701, *Oct.*, 1928.

With the aid of a modified apparatus of Andrews, Kohman and Johnston the authors determine the freezing points of the system β-chlorcrotonic acid — β-chloro isocrotonic acid and further calorimetric data, heat contents, specific heats and heats of fusion. In the former system the heats of solution by freezing point are higher than the calorimetric values, and the activities deduced from the thermal data are greater for each component than the corresponding mole fractions by 8 % maximum at the eutectic point. Geometrical isomers would then appear slightly to deviate from mutual ideality, but less polar isomers might prove to be more nearly ideal. H. B.

877. Measurements of Isothermals (of Neon) at High Pressures. A. Michels and R. O. Gibson. *Ann. d. Physik,* 87. 6. *pp.* 850–876, *Nov.* 22, 1928.

Gives details of the isothermal curves of neon under pressures ranging from 30 to 500 atmospheres, temperatures from 0° to 100° C., obtained by an extension of methods originally developed by Michels [see Abstracts 5 and 1361 (1924)]. An absolute accuracy of 1 part in 2000 is claimed. The original must be consulted for experimental details. The second virial coefficient of Kamerlingh Onnes is found in very good agreement with the values of Holborn and Otto [see Abstract 2549 (1925)] obtained at lower pressures. H. R. R.

878. Velocity of Ignition of Combustible Liquids in Air. H. Mache. *Akad. Wiss. Wien, Ber.* 137. 2*a*. *No.* 7. *pp.* 455–462, 1928.

The differences between the processes of combustion and ignition are discussed. The ignition of a combustible liquid in air can proceed in three different ways, according as the gas layer in contact with the liquid surface (1) contains so little vapour that it is incombustible, (2) consists of a combustible mixture of air and vapour, or (3) contains an excess of vapour. A simple apparatus is described for measuring the ignition velocity of liquids, and by means of it the following liquids and liquid mixtures have been tested over a range of temperatures up to about 30° C.: class 2: toluol, alcohol, alcohol-water mixtures, benzene-carbon tetrachloride mixture; class 3: benzol, benzene, ether, acetone, pentane. The results indicate that a rapid rise in the ignition velocity only occurs so long as the vapour content of the gas layer in contact with the liquid surface does not exceed (or only slightly exceeds) that of the gas mixture for which the combustion velocity is a maximum. Possible causes of the continued slow rise, in the case of alcohol and toluol, of the ignition velocity above this limiting value are suggested. L. L. B.

879. Determination of the Pressure and Density of Moist, Saturated Ammonium Bromide Vapour. A. Smits and R. Purcell. *Chem. Soc., J. pp.* 2936–2944, *Nov.,* 1928.

Results are given of simultaneous measurements of the vapour pressures and vapour densities of ammonium bromide by means of the "densitensimeter" (*Chem. Soc., J. p.* 2409, *Sept.,* 1928). The relation between log p and 1/T is expressed by a straight line, so that the latent heat of evaporation between 300° and 400° is not a function of the temperature. This result indicated that most probably the vapour would be completely dissociated, and density determinations with the baroscope show that this is actually the case. Control of the density determinations by the extrapolation method—the pressures of the saturated and unsaturated vapours of a weighed quantity of the salt in a known volume—gave for the graph connecting log p and 1/T two straight lines and the intersecting point of the continuations gave the pressure and temperature of the first-saturated vapour; calculation from the results thus obtained indicated that the corresponding vapour density agreed with complete dissociation. In reality, the two straight lines do not intersect but curve and merge one into the other, so that perceptible adsorption takes place in the wall of the apparatus. Correction of the baroscope reading for this adsorption results in agreement with the second method. The heat of evaporation of ammonium bromide is calculated to be 44,000 cal. T. H. P.

880. Determination of the Pressure and Density of Moist, Saturated Ammonium Chloride Vapour. A. Smits and W. de Lange. *Chem. Soc., J. pp.* 2944–2952, *Nov.*, 1928.

Results are given of measurements of the pressures and densities of moist, saturated ammonium chloride by means of the densi-tensimeter. It is found that the heat of sublimation is not a temperature function within the range 254–353°, and the density determinations, which show that the dissociation of the saturated vapour is practically complete over such range of temperature, furnish an explanation of this behaviour. Complete dissociation is also demonstrated by the extrapolation method [see preceding Abstract]. The molecular heat of sublimation for 1 gramme-molecule of ammonium chloride is calculated to be $39 \cdot 6 \times 10^3$ cal., and from the derived vapour-pressure formula the sublimation temperature is calculated as 339·3°. T. H. P.

881. Vapour Pressures of Aqueous Solutions of Potassium Iodide and Sodium Bromide at 25°. J. N. Pearce, M. D. Taylor and R. M. Bartlett. *Am. Chem. Soc., J.* 50. *pp.* 2951–2958, *Nov.*, 1928.

It is pointed out that of all properties of solutions the vapour pressure is the most accessible to thermodynamical treatment. The four general methods used for measuring vapour pressures of solutions and solvents are considered and reasons are given for the wide variation in the values obtained even by the same method and the same experimenter. The authors refer briefly to the Pearce and Snow method, which appears to eliminate all previous sources of error. This method is applied to concentrations of sodium bromide and potassium iodide lying between 0·1 *N* and saturated solutions. From the data obtained the osmotic pressures, the activities of the solute and solvent, the activity coefficients and the like are measured, and it is found that solutions of sodium bromide have always the higher values. J. K.

882. Vapour Pressures in Small Capillaries. Part I. Water Vapour. (A) Soft Glass Capillaries. J. L. Shereshefsky. *Am. Chem. Soc., J.* 50. *pp.* 2966–2985, *Nov.*, 1928.

The earlier work on the subject is reviewed. Among the investigators referred to are Laplace, Plateau, Drude, Quincke, Patrik and Ebermann, Kelvin, Parker, Coolidge, and Leslie, who was the first to show that the rise of a liquid in a capillary was due to the greater pressure in the stratum of liquid adhering to the wall. From the measurements of vapour pressures of liquids in small capillaries (the method employed being described) the present investigator establishes that the lowering of vapour pressure of water in small capillaries is much greater than can be accounted for by Kelvin's equation. It is shown that this greater lowering is due to the increase in surface tension. J. K.

883. Vapour Density of Formic Acid. H. C. Ramsperger and C. W. Porter. *Am. Chem. Soc., J.* 50. *pp.* 3036–3038, *Nov.*, 1928.

A survey has been made of all existing data on the vapour density of formic acid with the purpose of thereby making a graphical comparison. There is found to be complete agreement between the measurements made by Coolidge and those of Ramsperger and Porter. Traces of impurities were probably responsible for the discordant results of the earlier investigators. H. H. Ho.

884. Escape of Heat from an Harmonically Oscillating Hot Wire. R. S. Maxwell. *Phil. Mag.* 6. *pp.* 945–965, *Nov.*, 1928.

The author treats the theoretical and practical investigation of the case of a hot wire which is not at rest but oscillating harmonically. This side of the subject does not appear to have been previously treated. The experiments were made with a very fine platinum wire of diameter 0·0006 cm. in the grid of a Tucker hot-wire microphone. This grid was mounted on one prong of a tuning fork, electrically maintained in vibration. A compensating weight was added to the other prong. All extraneous draughts were excluded by enclosure of the apparatus in a proper box. The grid was arranged in one arm of a Wheatstone bridge circuit, and a balance was obtained with no vibration. The fork was then set in vibration and the cooling due to oscillation of the grid was measured by finding the new balance point in the circuit. If n be the frequency of the tuning fork, the hot wire was cooled owing to the periodic motion of this frequency through the air, and superimposed upon the steady fall of resistance. A periodic change, with a corresponding periodic change in current, was noted. The current, analysed by a vibration galvanometer, contained the fundamental and also harmonics of frequency, $2n$, $3n$, and $4n$. The wire is cooled by various factors: (1) The *free* convection effect. Dependent on the temperature of the wire, etc., and the same for stationary as for moving wire. (2) *Forced* convection effect. Due to the velocity of the wire through the air. Two factors are given rise to here: (*a*) The steady drop in resistance; (*b*) periodic changes of resistance of frequencies $2n$, $4n$, $6n$. The temperature of the wire, its diameter, and the velocity of the cooling draught are the determining factors in these regards. (3) The effect of heating the surrounding air, thus causing the presence of the fundamental and harmonics. The paper concludes with a mathematical theory founded on the results obtained. S. G. B.

885. Equation of State of a Substance at the Absolute Zero of Temperature and Properties connected with it. R. D. Kleeman. *Frank. Inst., J.* 206. *pp.* 631–646, *Nov.*, 1928.

Previous papers by the same author have determined the zero of the controllable energy (internal) and the entropy of a substance, together with some of its corresponding properties. This zero corresponds to the substance being in the condensed state under its vapour pressure at the absolute zero of temperature. The present paper extends this work in connection with the equation of state of a substance at the absolute zero of temperature, the results of which can be tested by numerical data. The thermodynamically obtained equation of state thus obtained falls into line with the equation of state of a mixture at any temperature obtained previously [Abstract 554 (1929)], the deduction of which was not thermodynamical. The paper deals with the various points under a series of headings, namely: (1) Properties of a substance or mixture in connection with its maximum work at the absolute zero of temperature. (2) The equation of state of a substance or mixture at the absolute zero of temperature. An expression is deduced which has a certain characteristic form from which a number of other important properties of matter at absolute zero of temperature can be derived. (3) An expression is derived for an absolute constant known as the "characteristic constant" of a substance. This is given by the equation $k = M_b B_0 / v_{b0}$. k is one of the important constants of nature. The characteristic constant of a substance at the absolute zero of temperature is shown to be proportional to the atomic volume or the volume occupied by 1 gramme-atom at the absolute zero of control. (4) The additive nature of the atomic volumes of the constituents of a mixture at the absolute zero of control is vindicated and the result sustained by facts, as is shown by Traube. (5) The ratio of the vapour pressures at absolute zero is shown to be unity; although the pressures themselves are zero, yet their ratio is finite and equal to unity. Substances will, therefore, mix in all proportions at the absolute zero of temperature. (6) The pressure at any given state at the absolute zero of temperature is determined. (7) The change in internal energy and the work of compression at absolute zero. For a mixture and a pure substance we have the relationship for the internal heats of evaporation (L): $L/L_a = v_0/v_{a0}$. (8) The zero of the internal energy of a mixture or substance under constraint. (9) Properties of inductivity. (10) Magnetic properties. Equations are given by which the permeability of a mixture at the absolute zero can be calculated from the permeabilities of the constituents. (11) Mixing substances under pressure p at absolute zero. It is shown that the work done is the sum of the work done in compressing the isolated constituents. (12) The radiation properties of substances at absolute zero are illustrated by means of a table of numerical results. It is shown that the absorbing power of a mixture at absolute zero can be expressed in terms of the absorbing powers of the isolated constituents. The paper is theoretical throughout. S. G. B.

886. Possible Generalisation of the Planck Radiation Formula. L. Strum. *Zeits. f. Phys.* 51. 3–4. *pp.* 287–291, 1928.

By means of the consideration of the characteristic functions for the absorption or emission of a light quantum a generalised formula for the Planck radiation law is deduced. A new expression is derived for the coefficient of the Stefan-Boltzmann equation, and the discrepancy between the theoretical and experimental values is explained. c_3 is given as $1{\cdot}82 \times 10^{-7}$. S. G. B.

887. Possible Deduction from the Planck Radiation Formula. K. Schaposchnikow. *Zeits. f. Phys.* 51. 11–12. *pp.* 895–898, 1928.

Three hypotheses are enunciated: (1) Black-body radiation consists of wave groups. Each group has the following limitations: $\frac{\lambda^2}{\Delta\lambda} = \frac{c}{\Delta\nu}$, where λ is the mean wave-length, $\Delta\lambda$ is the difference between the longest and the shortest wave-length of the group and has a constant value in this case. (2) The energy of each wave group is given by $i \,.\, h \,.\, \nu$, where i is a statical whole number. (3) Each wave group has a cross-sectional area of a mean value given by $\overline{q} = \frac{1}{2}\cdot\frac{\lambda^2}{2\pi} = \frac{c^2}{4\pi\nu^2}$. The reasons for these assumptions are given in that the first is a consequence of the classical wave theory, the second in that each group must be considered as a combination of the light quanta, and the third is justified on the basis of the mechanical light quantum theory. The volume of a wave group is deduced from (1) and (3) to be $\nu = \frac{c^3}{4\pi\nu^3\Delta\nu}$. If c denotes the group velocity, which differs little from the phase velocity, then, finally, it is shown that the following relationship can be deduced:

$$\mathrm{E}_\nu = \frac{2h\nu^3}{c^2} \cdot \frac{\Delta\nu}{e^{\frac{h\nu}{k\mathrm{T}}} - 1}.$$

S. G. B.

888. Theory of the Single-Plate Radiometer. T. Sexl. *Zeits. f. Phys.* 52. 3–4. *pp.* 249–262, 1928.

An exact theory of the radiometer is put forward in which the plate is considered as the limiting case of a rotational ellipsoid. By means of radiation currents a temperature gradient exists on the surface of the ellipsoid, so that conditions of the Maxwell thermal tangential currents are set up. From this the problem is seen to have a hydrodynamical analogy, and the radiometer force is defined as the force which the streaming gas exercises in the origin of the stationary rotational ellipsoid. The radiometer force is, therefore, given by the expression

$$\mathrm{R} = \frac{14 \cdot 72}{n + 5} \cdot \frac{\delta}{n_2} \cdot \mathrm{J} \cdot \frac{p \cdot l^2}{\mathrm{T}},$$

which gives the correct relationship between the intensity of the radiation, the gas pressure, and the nature of the gas itself. S. G. B.

889. Radiation Screens and Economic Light Distribution. F. Skaupy. *Zeits. f. Phys.* 51. 5–6. *pp.* 388–394, 1928.

The radiation loss in the energy distribution of an incandescent body by fireproof screens is shown by simple examples to be very considerable. By the proper choice of the screens (transparent to light but opaque to heat) the most economic system of illumination can be attained. The subject is treated mathematically throughout, and the results are applied to electric ovens, etc. S. G. B.

890. Molecular-Statistical Thermodynamics. E. Svenson. *Ann. d. Physik,* 87. 3. *pp.* 424–460, *Oct.* 12, 1928.

A theoretical discussion in which it is shown at the outset that in the molecular-statistical thermodynamics the "free volume" can be used in place of the "place coordinates." By "free volume" is meant the portion of space in which an individual molecule is found at each single moment of its flight. With the help of this assumption, the general chemical thermodynamical relations for a system of multiphases and components is statistically deduced. Under special conditions the equation for an ideal gas (including the tetrode value of the entropy constant and the chemical constant for monatomic gases) was worked out. The method was successfully applied to the derivation of equations for the mixtures of ideal gases, thermal dissociation of gases, van der Waals' equation of state, the Einstein theory of solid bodies, and also an expression for vapour-pressure curves under prescribed conditions. S. G. B.

SOUND.

891. Passage of Sound through Contiguous Media. R. W. Boyle and W. F. Rawlinson. *Roy. Soc. Canada, Trans.* 22. *Sect.* 3. *pp.* 55–68, *Jan.*, 1928.

A theoretical paper giving the details of a solution of the problem of the passage of sound through three contiguous homogeneous media with interfaces plane and parallel, and also details of the transmission through a homogeneous partition in an infinite medium when the angle of incidence is varied. The results are expressed in a form convenient to researches in ultra sonics, at which frequencies they can now be conveniently tested. W. H. Ge.

892. Distribution of Sound-Energy in an Enclosed Space. K. Kurihara. *Phys. Math. Soc. Japan, Proc.* 10. *pp.* 71–78, *May*, 1928. *In English.*

A mathematical paper dealing with the distribution of sound energy inside a building in which the form of the walls is irregular to a considerable, but finite, extent. The author introduces the term " convergence factor " in order to render his mathematical deductions more amenable to practical application. A distinction is made between a " focus " in the ordinary sense and a " recurrence point." The latter refers to a point through which sound waves pass repeatedly after every reflection with equal probability, as is realised, for example, when the point is situated at the centre of a spherical space. The " focussing " of rays is indeed necessary for the existence of any " recurrence point," but is not necessarily the same thing; the " recurrence point " has a close connection with the reverberation, whereas the focus has not necessarily. The idea of a recurrence point, in such a sense, is more physical (compared with geometrical) and more dynamical (compared with statical). The author further illustrates this point in dealing with two types of whispering gallery: (*a*) the focussing type, and (*b*) the conducting (or creeping) type, as classified by Sabine. A. B. W.

893. Piezo-Quartz Plates for Sending and Receiving High-Frequency Acoustic Oscillations. F. W. Hehlgans. *Ann. d. Physik*, 86. 4. *pp.* 587–627, *July* 10, 1928.

Uses piezo-quartz plates as acoustic receivers by putting them in circuit with a galena detector and a moving-coil mirror galvanometer. The detector is calibrated by means of a thermoelement. In order to tune two quartz plates to resonance, the distance between the plates and their electrodes is varied. The oscillating quartz can be regarded as a combination of a capacity, an inductance, and an ohmic resistance in series, and the gap between the quartz and its electrodes acts as a capacity. A displacement of the electrode by 1 millimetre in one experiment increased the resonance current from three divisions to a maximum of 15 divisions. If two plates are cut to the same dimensions from the same piece of quartz, their frequencies are the same to within 0·01 %. Various measurements of sound of frequencies of about 70,000 are described. The distribution of intensity in azimuth closely corresponds to theory. E. E. F. d'A.

894. Vibrations of Circular Plates and Rings. W. Hort and M. Koenig. *Zeits. f. techn. Phys.* 9. 10. *pp.* 373–382, 1928.

Theoretical and experimental study of the modes of vibration of circular plates and rings under electrical excitation. Many photographs of the modes actually realised are included. W. H. Ge.

895. Acoustical Properties of Conical Horns. K. Satô. *Tokyo Univ. Aeronaut. Research Inst., Report No.* 42. [19 *pp.*], *Sept.*, 1928.

The intensity of sound received through a conical horn with its axis set at different angles θ to the ray of sound was measured with a Rayleigh disc. The intensity distribution depends mainly upon the wave-length (λ) of the sound and only slightly upon the geometrical shape of the conical horn if the diameter (d) of the opening be the same. If λ be small compared with d, the sound energy is considerable for small values only of θ. If λ is large compared with d, then the sound energy is nearly equal for all values of θ. Hence to get a faithful record of a sound when a conical horn is used as a collector the source must be set in front of the horn ($\theta = 0°$), otherwise all higher overtones will be missing. The distortion of sound by a conical horn is due more to the dependence of intensity on λ than to resonance. W. H. Ge.

896. Architectural Acoustics. A. G. Huntley. *Roy. Soc. Arts, J.* 76. *pp.* 1146–1158, *Oct.* 12; 1163–1177, *Oct.* 19, *and pp.* 1181–1189, *Oct.* 26, 1928. *Cantor Lectures.*

An account of three lectures covering a range similar to the book of Davis and Kaye. The third lecture deals with some actual buildings and gives details probably not available elsewhere. W. H. Ge.

897. Velocity of Sound in Air, N_2 and O_2. W. G. Shilling and J. R. Partington. *Phil. Mag.* 5. *pp.* 920–939, *Nov.*, 1928. *Supplement.*

From measurement of the velocity of sound in chemically pure gases the molecular heats of air, nitrogen and oxygen have been determined over a temperature-range of 0° C. to 1000° C. Further measurements for air up to 1300° C. are added, and a reply is given to criticism of the method of determining the tube constant. W. H. Ge.

898. Photographic Method of Measuring Pitch. M. Metfessel. *Science*, 68. *pp.* 430–432, *Nov.* 2, 1928.

A method of recording pitch variations is described, which in certain respects may be regarded as a combination of the usual photographic wave-form recorder and a stroboscopic method. The same synchronising arrangements as in stroboscopy are employed. The " vibrating " light ray (*e.g.*, from a tilting mirror device) passes through the equally spaced apertures of the rows on a stroboscopic disc or drum and falls on a photographic film on the other side. If the film is stationary, and each flash of light meets a hole in the revolving disc at the same position every time, dots will be photographed; the frequency of vibration is the same as the number of holes in this row passing a given point per second. Other rows of holes which do not meet the flashing light at the same place each time distribute the light over a line, and the record shows a series of " dashes " instead of dots as at the correct synchronous frequency. A continuous record of such effect is obtained on a moving film. The original paper should be consulted for further details of the method. In illustration, a record of Galli-Curci's voice is reproduced, the rise and fall of pitch being clearly indicated. A. B. W.

ELECTRICITY AND MAGNETISM.

THEORY, ELECTROSTATICS, AND ATMOSPHERIC ELECTRICITY.

899. Propagation of Stationary Electric Currents in a Conductor exposed to the Action of a Uniform Magnetic Field. Elena Freda. *Accad. Lincei, Atti,* 7. *pp.* 716–720, *May* 6, 1928.

The first part of a mathematical investigation of this case, to be followed by a further discussion. J. J. S.

900. Wave Mechanics of the Rotating Electron and Fundamental Equations of the Electromagnetic Field. J. Frenkel. *Zeits. f. Phys.* 52. 5–6. *pp.* 356–363, 1928.

Supplementary to previous work [see Abstract 1843 (1928)], the fundamental equations of the wave mechanics of an electron have been investigated as a generalisation of the Maxwell field equations and the corresponding d'Alembert equations. By suitable modifications of the previous hypotheses, a system of eight equations are derived which may be combined pairwise to give the four equations of the Dirac theory. The quadratic quantities which determine the charge and stream density are found to be analogous to the energy density and the Poynting vector. A generalisation of the energy-impulse-tensor, however, has not been accomplished, so that the analogy between the electronic and the electromagnetic waves still remains very limited. H. H. Ho.

901. Reasons why an Elementary Electric Charge Cannot Disintegrate into Smaller Charges. W. Anderson. *Ann. d. Physik,* 87. 4. *pp.* 536–542, *Oct.* 12, 1928.

The argument is based on an application of the Fermi statistics to the electric " gas " which would result if an electron were allowed to explode in an enclosed chamber. Disintegration into an " infinite number of sub-electrons of infinitely small charge and mass " leads to infinite zero-point energy, which is excluded. Disintegration into a finite number of sub-electrons is shown to be impossible unless the charge of the original electron exceeds a certain minimum which is probably greater than $1 . 10^{-9}$ e.s.u. If this holds good, the stability of the electron and the proton is explained, for their charges equal only $4 \cdot 77 . 10^{-10}$ e.s.u.

W. S. S.

902. Fundamentals of Electrodynamics. W. F. G. Swann. *Frank. Inst., J.* 206. *pp.* 571–595, *Nov.*, 1928.

The historical development of the fundamental equations of electrodynamics from before Maxwell's time is sketched, and a discussion given of the meaning of the laws in their present form, introducing the electron theory and relativity. The manner in which Schrödinger's wave function may enter into the general scheme is indicated. W. S. S.

903. Potential Functions due to Certain Plane Boundary Distributions. C. Fox. *Phil. Mag.* 6. *pp.* 994–1008, *Nov.*, 1928.

A general method is developed for finding the solution of Laplace's equation for the potential function throughout space, when either the potential or the charge is known over (1) a plane, or (2) two parallel planes. The method is applied to the following problems: the guard-ring, the freely charged elliptic disc, and the case of an infinite conductor bounded by two parallel planes with two elliptical disc electrodes, applied so that the join of their centres is perpendicular to the bounding planes. The essence of the method is a theorem due to Neumann, which states that

$$2\pi f(r, \phi) = \int_0^\infty u\,du \int_{-\pi}^{\pi} \int_0^\infty f(\mathrm{R}, \Phi) \,.\, \mathrm{J}_0[u\sqrt{\mathrm{R}^2 + r^2 - 2\mathrm{R}r\cos(\Phi - \phi)}]\mathrm{R}d\mathrm{R}d\Phi$$

provided $f(\mathrm{R}, \Phi)$ satisfies certain analytical conditions. W. S. S.

904. Number and Mobility of the Small Ions in the Atmosphere. W. J. Baranow and E. S. Stschepotjewa. *Phys. Zeits.* 29. *pp.* 741–750, *Nov.* 1, 1928.

The number and mobility of the ions in the air in different places and under various conditions were measured by Ebert's ion counter. There were great divergences, so that the mean mobility in no way expresses the mobility of certain groups of ions. Certain low values obtained do not express the mobility of the light ions in the atmosphere, which in all probability is not under 1·2 cm./sec.: volt/cm. for positive and 1·6 cm./sec.: volt/cm. for negative ions. The conclusion is reached that it is scarcely of interest to conduct measurements of ionic mobility in the atmosphere in the future as has been done hitherto. It is necessary to divide the ions into groups (even roughly into light, medium and heavy) and to determine the average mobility of each group separately, and for this special and accurate apparatus is necessary. J. J. S.

DISCHARGE AND OSCILLATIONS.

905. Alternate-Current Brush Discharge Phenomena. A. Pochettino and G. Fulcheris. *N. Cimento,* 5. *pp.* 143–166, *May,* 1928.

The rectifying action of a point discharging to a plate in a low vacuum varies greatly and irregularly with the current strength. The authors study the phenomena in various gases at pressures ranging from 2 to 100 mm. of mercury, and endeavour to give a theoretical explanation of some observed peculiarities. E. E. F. d'A.

906. Photographic Determination of Kathode Temperatures in the Electric Arc. E. C. G. Stückelberg. *Helv. Phys. Acta,* 1. 2. *pp.* 75–109, 1928. *In German.*

A new photographic method for determining high temperatures is described. The accuracy is of the order of 20° at temperatures of 2000° K. and of 80° at 4000° K. Only a momentary exposure is required, and hence it appears to be preferable for many purposes to pyrometric methods. Assuming the true temperature of a carbon anode in air to be 3820° K., the temperature distribution at the kathode of a tungsten arc was measured. In the current interval from 0·25 to 5·0 amperes the temperature was found to be independent of gas pressure, arc length and anode shape. The current density calculated from the electrode shapes and the temperature corresponds in its functional behaviour with Richardson's law and is in agreement with the measured values. A. W.

907. Electronic Emission in a Vacuum Tube. L. Tieri and V. Ricca. *Accad. Lincei, Atti,* 7. *pp.* 720–726, *May* 6, 1928.

The electronic emission in an incandescent filament in a vacuum is accompanied by a variation in the intensity of the current which feeds the filament itself. This variation being connected with the work of separation of the electrons, has furnished a means for determining the intrinsic potential of some metals. The paper gives an account of an investigation of the relation existing between the variations of the current of the filament and those of the electronic current when the difference of potential between the filament and the plate is varied. The authors postpone the consideration of the interpretation of the results till a later paper. J. J. S.

908. Phases of the Thermionic Saturation Current. C. Dei. *Accad. Lincei, Atti,* 7. *pp.* 644–649, *April* 15, 1928.

Thermionic tubes with two electrodes present in the phase of saturation the singular fact that the current intensity does not reach a value rigorously constant, because with the increase of the potential V between the plate and the filament it increases approximately in a linear way. In the phase of saturation the relation $i = j + k\text{V} = j(1 + \alpha\text{V})$ holds, where j, α, k are constants that depend on the temperature of the filament, whilst their ratio $\alpha = k/j$ for one given thermionic valve is independent of it. In this note a mathematical investigation is made of what occurs in a circuit which has in series a valve, an ohmic resistance R, a coil with a coefficient of self-induction L, and a pulsating e.m.f. of the type $\text{E} = \text{E} + \text{E}_0 \sin \omega t$, starting with the two relations which must hold simultaneously:

$$\text{E} = i\text{R} + \text{L}\frac{di}{dt} + \text{V} \quad \text{and} \quad i = j + k\text{V},$$

where V is the instantaneous difference of potential between the plate and the filament. J. J. S.

909. Thermionic Valve Circuit with a Condenser in a Derived Circuit. C. Dei. *Accad. Lincei, Atti,* 7. *pp.* 730–732, *May* 6, 1928.

Having examined in a previous paper [see preceding Abstract] the intensity and the phases of the current in a circuit in which there are in series a thermionic valve, a resistance, a self-induction and a pulsating e.m.f. sufficient to maintain the valve constantly in the saturation phase in which the intensity is able to behave within wide limits as a linear function of the difference of potential between the plate and the filament, the author considers in the present paper the case of such a circuit with a capacity added as a derived circuit on the poles of the valve. With this arrangement the valve can still be maintained in saturation. J. J. S.

910. Systematic Variations of the Constant A in Thermionic Emission. L. A. DuBridge. *Nat. Acad. Sci., Proc.* 14. *pp.* 788–793, *Oct.,* 1928.

In the Richardson-Dushman equation $\text{I} = \text{AT}^2 e^{-b/\text{T}}$ the author finds the empirical relation that whenever the work function b of a given surface is changed by heating, outgassing, coating, etc., A also changes, so that log A is a linear function of b. This is shown to be the case by means of a number of graphs containing the results of the author and of other observers for several different metals. It is shown that the observed variations in A might be ascribed to a small temperature variation of the surface work function. H. N. A.

911. Increase of Thermionic Currents from Tungsten in Strong Electric Fields. R. S. Bartlett. *Roy. Soc., Proc.* 121. *pp.* 456–464, *Nov.* 1, 1928.

Schottky has pointed out that there should be an increase in thermionic currents above the saturation value with the application of strong electric fields. He assumes that an electron is prevented from escaping by the attraction of its electric image in the emitting wire, and that the external field neutralises part of this image force field. The author's experiments were carried out with a tungsten wire, concentric in a molybdenum cylinder, the whole mounted in a quartz tube which permitted thorough bathing in an electric furnace. The temperature was maintained sensibly constant throughout a series of observations. Maximum fields between 30,000 and 60,000 volts per cm. were employed. The results for the increase of thermionic currents with applied electric field show general agreement with theory, but the departures from a predicted straight line are greater than can be accounted for by experimental deficiencies. In the dependence of this rate of increase upon temperature the failure of experiment to agree with theory is still more marked. It is suggested that Schottky's equation should be modified to take account of the influence of neighbouring electrons close to the surface—electrons that emerge from the surface but do not completely escape. Surface impurities in the kathode have a marked effect upon the experimental results. J. J. S.

912. Liberation of Secondary Electrons by Electrons of 1 to 30 Kilovolts. E. Buchmann. *Ann. d. Physik*, 87. 4. *pp.* 509–535, *Oct.* 12, 1928.

The gases investigated were air, Ar, H_2 and CO_2. The number of secondary electrons produced per cm. path in the gas at 1-mm. pressure was found to decrease steadily with increase in the velocity of the primary electrons from 1000 volts upwards. In particular, for argon no discontinuity in the variation occurred at the K-limit (2900 volts), at least none exceeding 3 %, the precision of measurement. A number of measurements of the total electron number—*i.e.*, the total number of electrons generated by an electron throughout its path—showed a proportional relation with the energy of the primary electron. The range of the primary electrons computed from the measurements varied as the fourth power of the velocity, in agreement with all previous determinations. W. S. S.

913. Effect of Electric Fields on the Emission of Electrons from Conductors. A. T. Waterman. *Roy. Soc., Proc.* 121. *pp.* 28–40, *Nov.* 1, 1928.

Houston has recently proposed an explanation of the extraction of electrons from metals by intense electric fields, which is based on Sommerfeld's modification of the Lorentz electron theory of metals. The author has investigated the problem from the same standpoint, but reached the conclusion that such an explanation is inadequate, at least in its present form. An expression is derived on the Sommerfeld theory for the thermionic current in the presence of an electric field, and difficulties are pointed out in the way of accepting this effect as the correct explanation of the "field currents" examined by Millikan and Eyring, Gossling, del Rosario and others. Incidentally, it is shown that if the Sommerfeld theory is accepted the expression for the Schottky effect should be modified, and this modification becomes significant at high fields. A. W.

914. Diffusion of Slow Electrons in the Rare Gases. H. Pose. *Zeits. f. Phys.* 52. 5–6. *pp.* 428–447, 1928.

According to Hertz, the movement of slow electrons under the influence of an electric field must be treated as a diffusion problem. This was tested by experiments on neon, argon, and a mixture of neon and helium. An investigation was also carried out as to how far Hertz's theory is in agreement with the phenomena of impacts between electrons and atoms. The results obtained show that, within the limits of error of the measurements, the movement of slow electrons in the rare gases is in good agreement with the diffusion theory. A. W.

915. Effect of Refraction on Electron Diffraction. G. P. Thomson. *Phil. Mag.* 6. *pp.* 939–942, *Nov.*, 1928. *Supplement.*

A criticism of a paper by Rupp [Abstract 264 1929)]. It is suggested that there is an oversight in Rupp's method of calculation which greatly modifies the conclusions which may be drawn from his experiments. The supposed effect of refractive index is only a few per cent. in any case, and it is on the limit of the accuracy of the experiments. The discrepancy left when the modified calculation is made may perhaps be accounted for by a slight systematic error in the measurement of the electron velocities. W. H. GE.

916. Electronic Diffraction by a Ruled Grating. E. Rupp. *Zeits. f. Phys.* 52. 1–2. *pp.* 8–15, 1928.

The diffraction of electrons was observed for different angles of incidence on a ruled grating for 70-, 150- and 310-volt electrons. The de Broglie formula $\lambda = \frac{h}{mv}$ for the wave-length of the electron waves is in agreement with the results to within 2 %. The wave-lengths were deduced by a relative method, and also by an absolute method in which the diffraction was observed (in the case of 150-volt electrons) for the first three orders. A. C. M.

917. Rate at which Particles take up Random Velocities from Encounters According to the Inverse Square Law. L. H. Thomas. *Roy. Soc., Proc.* 121. *pp.* 464–475, *Nov.* 1, 1928.

The theory is developed with reference to beams of electrons moving through highly ionised gases. The formulæ obtained for low densities lead to "effective mean free paths" shorter than might have been expected. Jeans has dealt with the problem in connection with stellar encounters, but neglects encounters in which the closest distance of approach is less than the normal distance between adjacent stars; this would lead to too great an error in atomic problems, and the question is treated in such a way as to avoid this error. Both near and distant encounters are dealt with mathematically, and formulæ are obtained which include all the encounters. Langmuir's results with a beam of electrons passing through ionised mercury vapour are considered in detail in the light of the theory. It would appear that to account for the observed effect nearly all the mercury atoms must have been doubly ionised, but that it seems not entirely impossible that his observations can be accounted for as due to scattering due to positive ions and secondary electrons. H. N. A.

918. Influence of Positive Ions on the Electronic Space Charge within a Two-Plate System. Henny Cohn. *Ann. d. Physik*, 87. 4. *pp.* 543–569, *Oct.* 12, 1928.

The neutralisation of the electronic space charge in a triode tube (hot filament between two parallel plates forming "anode" and "grid" respectively), due to positive ions, was observed by taking "grid" volts-"anode" current characteristics with different amounts of gas in the tube. Working with helium, argon, and nitrogen, the reduction in the space charge was found to be proportional to the gas pressure, to the mass of the gas atoms, and inversely proportional to the absorption of electrons by the gas molecules. The rôle played by the ionisation potential of the gas was also investigated. Reduction of the negative space charge, using a stream of positive calcium ions emitted by a hot filament, could also be effected, and comparison of the results obtained by the two methods gave an estimate of the positive ion current necessary to neutralise completely the electronic space charge. For the particular electrode system and plate potential worked with this amounted to 2 milliamperes. W. S. S.

919. Mobility of Ions in Air. Part IV. A. M. Tyndall, L. H. Starr and C. F. Powell. *Roy. Soc., Proc.* 121. *pp.* 172–184, *Nov.* 1, 1928.

Two methods of measuring mobility, both of which have a high resolving power, are described. One of these is similar to that recently employed by v. d. Graaff [see Abstract 3084 (1928)]. The results obtained give a higher value than found previously for the rate of transformation of the positive ion in air. It was found that at long ages the positive ions in air have mobilities distributed over a small range with a mean value of about 1·25, which is independent of the humidity. No evidence was obtained of initial positive ions in very dry air or in pure nitrogen. In air containing alcohol vapour the mobility of both the negative and positive ions was found to be independent of the age of the ions from 1/65 to 2/3 second. [See also Abstract 2431 (1926).] A. W.

920. New Method of Determining the Ionisation Tensions of the Elements. S. Datta and S. Sen. *Zeits. f. Phys.* 50. 11–12. *pp.* 849–860, 1928.

Investigates the ionisation by combined thermal and electrical excitation in the Bunsen flame. This contains atoms with electrons of energy $V_r e$, where V_r denotes the tension exciting a given resonance line. On bombarding these atoms with electrons of suitable velocity they can be ionised, and this ionisation is tested for by noting the increase in the conductivity of the flame, which takes place as soon as the accelerating tension reaches the value $V_i - V_r$, where V_i is the ionisation potential. Salts of Na, K, Li, Mg, Ca, Sr, Ba, and Hg are studied by this method, and a satisfactory agreement with previous results is found. E. E. F. d'A.

921. Canal Rays between Metal Walls. J. Koenigsberger. *Zeits. f. Phys.* 51. 7–8. *pp.* 565–569, 1928.

Referring to Rüchardt's criticisms [see Abstract 2468 (1928)], the author points out that the action of neighbouring metal walls, *e.g.*, of a capillary, on the change of the charge of canal rays, depends on the fact that the rays by scattering at the gas molecules are deflected out of their path to the metal boundary and there upon grazing reflection have their charges changed. J. J. S.

922. Action of Metal Walls on Canal Rays. E. Rüchardt. *Zeits. f. Phys.* 51. 7–8. *p.* 570, 1928.

Koenigsberger considered [see Abstract 3174 (1927) and preceding Abstract] that in the measurements of the author on the action of metal walls on the change of the charges on canal rays grazing reflection took place at the surface of the narrowly separated plates of the measuring condenser, and that this accounted for the considerable weakening of the intensity of the radiation. But the author states in this note that there was no lessening of the free path observed, and he considers that such influences did not affect his earlier results. J. J. S.

923. Motion of Electrons in Gases. J. S. Townsend. *Roy. Soc., Proc.* 120. *pp.* 511–523, *Oct.* 1, 1928.

A detailed refutation is given of most of the criticisms of the author's work, advanced by R. d'E. Atkinson [see Abstract 2805 (1928)]. W. S. S.

924. Element of Time in the Photoelectric Effect. E. O. Lawrence and J. W. Beams. *Phys. Rev.* 32. *pp.* 478–485, *Sept.*, 1928.

Uses the Kerr cell electrooptical shutter previously described to determine the times of appearance and cessation, referred to the times of illumination and extinction of the light, of the photoelectric effect from a potassium hydride surface. The light flashes employed lasted 10^{-8} sec. The method used has yielded information as to the speed of operation of the above shutter, and has shown the steepness of the wave fronts resulting from spark discharges when travelling along wires. It is shown that photoelectric emission begins less than 3×10^{-9} sec. after illumination. The sum of the time required for the shutter to close and that during which photoelectric emission persists after the light is cut off is less than 10^{-8} sec. The paper concludes with a theoretical discussion, in which the photoelectric effect is regarded as a particular case of absorption of light in which the electron is completely removed from the atom; the excitation of an atom takes place in less than 10^{-10} sec., so that photoelectrons are probably ejected within a similarly short time after illumination, as the present experiments indicate. It is not, however, possible with the Kerr shutter to measure the time, if any, during which the photoelectric effect persists; it can only be said that it is less than 10^{-8} sec. H. N. A.

925. Velocity Distribution of Photoelectrons produced by Soft X-Rays. E. Rudberg. *Roy. Soc., Proc.* 121. *pp.* 385–422, *Sept.* 1, 1928.

The photoelectrons studied are those produced by the action of soft X-rays on solid conductors. A special method of magnetic analysis is used. There is evidence of a very small fraction of negatively charged atomic carriers in the emission. In all cases the emission can be described as constituted of a group of electrons with energies amounting to only a few volts, and a much less prominent group having energies chiefly concentrated in the region 200–280 volts. The first group is in most cases reduced by about 50 % by baking the targets at 400° C. The second group apparently consists of fast primary electrons produced directly by the incident radiation-quanta, while the first is the secondary emission resulting from the presence of such fast primaries in the target. The energy distribution among the fast electrons is satisfactorily accounted for by the assumption of an incident radiation chiefly consisting of the carbon K_a-line. A. D.

926. Production and Absorption of Soft X-Rays and Secondary Electrons. E. Rudberg. *Roy. Soc., Proc.* 121. *pp.* 421–432, *Nov.* 1, 1928.

A general discussion of the energy interchanges between soft X-rays and slow primary and secondary electrons occurring at the surfaces of solids [see also O. W. Richardson, Abstract 3046 (1928) and preceding Abstract]. The main heads of the discussion are: (1) Photoelectric efficiency; (2) efficiency of production of soft X-rays; (3) origins of secondary electron emission. H. R. R.

927. Photoelectric Thresholds and Fatigue. G. B. Welch. *Phys. Rev.* 32. *pp.* 657–666, *Oct.*, 1928.

Measurements of the photoelectric fatigue were made on various elements of the highest purity on which clean surfaces could be obtained in a high vacuum by means of an electromagnetic filing arrangement. It is shown that there is a linear relation between the logarithm of the photoelectric current and the logarithm of the time after polishing. Of the metals tested, calcium has the highest rate of fatigue, whilst germanium has the lowest. Thus, the rate of fatigue depends on the element used, as well as on the factors producing fatigue, for an increase in pressure produces an increase in the rate of fatigue. The rate of fatigue also increases for a given substance, as the wave-length at which photoelectric emission ceases is approached. Light has no apparent effect. Photoelectric threshold values are obtained for Ca, Fe, Co, Ni, Cu, Zn and Ge, and when a high vacuum is used there is no change produced by fatigue over a period of several hours. With lower vacua the threshold values tend to move towards shorter wave-lengths. The " patch " theory, partly suggested by Woodruff [see Abstract 825 (1926)] and Richardson and Young [see Abstract 1720 (1925)], is proposed to account for the above facts. Contamination is considered to take place at discreet areas on the surface of the element, thereby reducing the photoelectric current. R. C. F.

928. Photoelectric Properties of Thin Films of the Alkali Metals. N. R. Campbell. *Phil. Mag.* 6. *pp.* 633–648, *Oct.*, 1928.

The thin films mainly studied are those produced by depositing an alkali metal on some other material, driving it off by heat, and subjecting the remaining film to a discharge in hydrogen. By this process photoelectric kathodes can be produced that have very remarkable and stable sensitivity to red light; photoelectric currents can be obtained with light of λ8000 Å. of the same order as those obtained in normal potassium cells with light of λ4500 Å. The sensitivity depends very greatly on the material on which the film is deposited. The observations are closely related to those of Ives on the photoelectric properties of thin films and

to those of the many workers who have investigated the effects of gas films on photoelectric emission. The surfaces concerned almost certainly consist of a succession of monomolecular layers, similar to those of cæsium and oxygen on tungsten (Langmuir and Kingdon) or of barium and oxygen or other gases (Ryde). But the conditions of their formation are exceedingly complex, and little progress has been made towards an analysis of their constitution. The observations seem to have an important bearing upon attempts to correlate thermionic and photoelectric emission.
AUTHOR.

929. Reflection of Electrons from an Aluminium Crystal. D. C. Rose. *Phil. Mag.* 6. *pp.* 712–729, *Oct.*, 1928.

The reflection of a beam of electrons from an aluminium crystal has been studied by a method analogous to that employed by Bragg for the analysis of a beam of reflected X-rays. It is shown that electrons can be diffracted by a crystal grating and that the results agree quantitatively with those predicted by the wave theory. There is, however, no need to assume, as in the case of the experiments of Davisson and Germer on nickel [see Abstract 712 (1928)], the existence of a refractive index of the crystal for the waves greater than unity. Assuming an experimental error of 7 %, the greatest value the refractive index can have is 1·013, which corresponds to a surface potential of between 3 and 4 volts. The reason for the different behaviour of nickel and aluminium is not clear. F. J. W.

930. Motions of Electrons in Ethylene. J. Bannon and H. L. Brose. *Phil. Mag.* 5. *pp.* 817–824, *Nov.*, 1928.

It has been found [see Abstracts 970 (1922) and 44 (1926)] that in N_2, H_2 and O_2 the velocities of electrons in gases—W in the direction of the electric force, and U the velocity of agitation—depend only on the ratio of the electric force Z to the gas pressure p. The authors now find a similar result for ethylene, especially for values of Z/p greater than 5. Tables and graphs are given showing values of k and W with the corresponding values of Z/p, where k is the ratio of the mean kinetic energy of agitation of an electron to the mean kinetic energy of a molecule of the gas at 15° C. Curves connecting U with L, the mean free path of an electron in the gas at 1-mm. pressure, exhibit, like the curves for O_2 and CO_2, a very definite maximum, with a less definite minimum. Slow changes in k and W for any fixed value of Z/p may be accounted for by electron collisions. T. B.

931. Energy Losses of Electrons in Hydrogen. H. Jones and R. Whiddington. *Phil. Mag.* 6. *pp.* 889–910, *Nov.*, 1928. *Supplement.*

Electrons from a heated filament were accelerated by an electric field, and passed through a collision space containing hydrogen; they were then further accelerated by a second field, and passed through two slits into the photographic camera, the pressure in which was kept very low indeed; here they were deflected by a uniform magnetic field on to the photographic plate. Lines were observed on the photographs corresponding to groups of electrons, the velocity of each of which was nearly the same. One of these lines corresponded to electrons which had lost no velocity in collisions with H_2 molecules; another, which was found for all electron velocities down to about 13 volts, indicated the presence of electrons which had lost velocity corresponding to 12·6 volts, for 50 volts velocity and over this is by far the most probable effect produced by collision between an electron and an H_2 molecule, and corresponds apparently to the excitation of the C state with a certain amount of vibrational energy. The probability of effective collision at 150 volts is in the neighbourhood of 1 or 2 %. At low velocities smaller losses are observed, the upper limit being 8 or 9 volts, varying slightly with the primary electron velocity; it is suggested that these losses are connected with molecular dissociation, and the excitation of the continuous spectrum. The B_0 and other low vibrational B states are not stimulated directly by electron impact. There is very faint indication of direct dissociation at 8 to 10 volts. H. N. A.

932. Theory of Diffraction of Electrons by Crystals. H. Bethe. *Ann. d. Physik*, 87. 1. *pp.* 55–129, *Oct.* 5, 1928.

A theoretical treatment, based on wave mechanics, is given of the diffraction of electrons by crystals as observed by Davisson and Germer [see Abstracts 2471 and 2804 (1928)], by Rupp, by Thomson [see Abstract 1355 (1928)] and by others. To a first approximation the observed discrepancy between Röntgen-ray and electron diffraction can be explained by an index of refraction. From the observed index of refraction for nickel calculation gives the value 14·8 volts for the accelerating potential exerted by its crystals on electrons. The dynamics of the field of the de Broglie waves in crystals and the conditions at their surfaces are dealt with at some length. With the simplifying assumption that outside the primary beam only a single strong interference beam occurs, the dispersion equations are derived. From these, in close analogy with Ewald's dynamical theory of Röntgen-ray reflection, the accurate position of the reflection maxima and the "resolving power" of the crystal are calculated. The theory here developed is then applied to the results of various workers, with satisfactory agreement. A. W.

933. Perpendicular Deflection of Slow Electrons by Gas Molecules. R. Kollath. *Ann. d. Physik*, 87. 2. *pp.* 259–284, *Oct.* 5, 1928.

A detailed account is given of measurements of the deflection of slow electrons by gases, in a direction at right angles to that of the primary pencil. Quantitative measurements for the gases He, Ne, Ar, Kr, H_2, CO, CO_2, N_2O, CH_4, and for velocities in the primary beam corresponding to $1 - 6\sqrt{\text{volts}}$, showed for all the gases "perpendicular deflection" without change of velocity, varying in amount in the same general way with the primary electron velocity. Although all the gases gave a curve for the number of electrons deflected, against the primary velocity, with *one* maximum (in the neighbourhood $1 \cdot 5$ to $3 \cdot 0\sqrt{\text{volts}}$), significant differences in the form and position of the maximum enabled the following groups to be distinguished:—Argon group: Ne, Ar, Kr, CH_4; Hydrogen group: H_2, He; Nitrogen-carbon dioxide group: N_2, CO, N_2O, CO_2. Comparison with the curves for the effective cross-section of these gases [see Abstract 34 (1928)] showed agreement over the whole range for the hydrogen group, agreement over the initial portion ($\sqrt{\text{volts}}$ small) for the argon group, and agreement as regards the first maximum in the effective cross-section curves, for the nitrogen group. W. S. S.

934. Effect of Gases on the Photoelectric Sensitivity of Charcoal. O. v. Auwers. *Zeits. f. Phys.* 51. 9–10. *pp.* 618–637, 1928.

Investigates the photoelectric sensitivity, p.s., in a high vacuum, and finds that it diminishes as the gas content of the charcoal decreases. When no voltage is applied to the charcoal the p.s. rises at first after heating to red heat, outglowing, falling again asymptotically in the course of a few hours. When voltage is applied the p.s. rises after outglowing and approaches asymtotically a limiting value in a few hours. This renewal of the p.s. after outglowing takes place to a first approximation independently of the pressure in the apparatus. H, O and air increase the p.s. of charcoal when adsorbed layers of gas on the surface are avoided. The experiments lead to the conclusion that the deeper layers of sorbed gases are involved in the process, and that the seat of the normal p.s. is not to be found at the surface of the charcoal; the way in which the atoms of gas are bound in the interior of the solid must make their exterior electrons capable of removal by the action of light, the atoms of the solid being unaffected. H. N. A.

935. Photoelectric Long-Wave Limit of Potassium Vapour. R. C. Williamson. *Nat. Acad. Sci., Proc.* 14. *pp.* 793–796, Oct., 1928.

Using a monochromator in conjunction with a mercury arc, the ionisation produced in potassium vapour issuing from a jet was measured for different wave-lengths of incident light. Ionisation was found to set in sharply near 3027 Å., there being a further sharp increase in the ionising efficiency of the light at about 2610 Å. as found by Lawrence. The spectroscopic limit for the potassium atom is, however, 2856 Å., and an explanation of the observed effects is advanced, assuming molecular ionisation with and without dissociation, the limits corresponding to these two cases being set equal to 2610 Å. and 3027 Å. respectively. The dissociation potential of the neutral molecule calculated on this hypothesis equals 0·42 volt, which is rather lower than the value 0·61 volt estimated by Carelli and Pringsheim by an entirely different method. W. S. S.

936. Emergent Energy of Photoelectrons in Potassium Vapour. R. C. Williamson. *Nat. Acad. Sci., Proc.* 14. *pp.* 796–801, Oct., 1928.

Preliminary experiments are described in which the energy of the photoelectrons emitted by potassium vapour was determined for different wave-lengths of the exciting radiation. For a wave-length of 3027 Å. the emission velocity (expressed in volts) was found to be zero to within 0·1 volt, and for a wave-length 2399 Å., a value of 1·3 volts was obtained. Assuming the latter radiation capable of ionising with and without dissociation [see preceding Abstract] and calculating the maximum emergent energy from the 3027 Å. limit, a value of 1·07 volts is to be expected, *i.e.*, there is a discrepancy of 0·23 volt. This is regarded as fairly satisfactory. W. S. S.

937. Effect in Glow-Discharge Tubes. H. J. Reich. *J.O.S.A. and R.S.I.* 17. *pp.* 271–288, *Oct.*, 1928.

Many glow-discharge tubes containing neon, helium, or argon are affected in their behaviour by external illumination, the sparking potential being lower when the tube is illuminated than when it is dark. The author's investigations go to show that this is a true photoelectric effect produced by the presence of small amounts of alkali metals on the electrodes and walls. E. E. F. D'A.

938. Electric Surges. W. Rogowski and E. Flegler. *Arch. f. Elektrot.* 20. *pp.* 635–636, *Sept.* 17, 1928.

The authors have previously given results obtained photographically, using a kathode-ray oscillograph, for the incidence of electric surges [see Abstract 2143 (1925)]. The apparatus employed has been improved, making it possible to record surge phenomena of periods ranging down to $0 \cdot 4 \times 10^{-6}$ second. Photographs are given of damped oscillations of frequencies $9 \cdot 1 \times 10^3$, 245×10^3 and $1 \cdot 1 \times 10^6$ cycles per second. A photograph is also given showing the inception of a surge in a conductor of length 60 m. to which a potential of 5000 volts was suddenly applied. The period of the resulting oscillations is seen to be of the order of $0 \cdot 4 \times 10^{-6}$ second. A. W.

939. Study and Measurement of Ultra Short Waves. B. Mazumdar. *Indian Journ. Phys.* 3. *pp.* 77–93, *Sept.* 30, 1928.

In order to produce very short electric waves the author employs a circuit similar to that of van der Pol, with a triode valve in which regenerative effect is obtained by the interelectrode grid-plate capacity; the best results were obtained with a French transmitting valve. Other circuits were experimented with, in which two valves were used. With Englund's circuit, in which the grid-plate capacities of the two valves are in series, powerful oscillations could not be obtained, but using a second circuit with the two interelectrode capacities in parallel very good results were obtained. A theory has been worked out for the modified van der Pol method, which is regarded as tentative; values of λ calculated by this theory for different cases are 5·38, 5·07 and 4·18 m., while the observed values are 5·4, 5 and 4 m. H. N. A.

940. Wehnelt Interrupter as Generator of Electromagnetic Oscillations. W. M. Schulgin. *Phys. Zeits.* 29. *pp.* 724–726, *Oct.* 15, 1928.

The arrangement described resembles that of an arc generator. The positive terminal of a 120-volt d.c. supply is connected through a choke to three incandescent lamps in parallel and thence to the lead plate of the Wehnelt interrupter, whose platinum point is connected through a second choke to the negative supply terminal. Two of the lamps had carbon filaments, the third being a 100-watt metal filament lamp. The interrupter electrodes were connected through condensers to an inductance included in a small aerial. The radiation from this aerial was easily observed at distances up to 40 m. The wave-length emitted was of the order of 200 m. A. W.

941. Echo produced by Short Electromagnetic Waves arriving several Seconds after the Emission of the Signal, and its Explanation in accordance with the Theory of the Aurora Borealis. C. Störmer, with a Note by H. Deslandres. *Comptes Rendus*, 187. *pp.* 811–812 *and* 813, *Nov.* 5, 1928.

A series of echoes, arriving at Oslo at intervals ranging from 3 to 15 sec. after the emission of the signal by means of waves of length 31·4 m. at Eindhoven, has been observed. The echo was occasionally double. Attributing these echoes to waves reflected by currents or corpuscles in celestial space far beyond the Heaviside layer, the existence of which are contemplated in the author's theory of the aurora, it is shown that the calculated interval ranges from 4 to 15 sec. Deslandres attempts to show that, when this rather capricious phenomenon has been clearly observed, there is probably considerable solar electronic activity.

J. S. G.

ELECTRICAL PROPERTIES AND INSTRUMENTS.

942. New Determination of the International Unit of Electrical Resistance. H. v. Steinwehr and A. Schulze. *Ann. d. Physik*, 87. 6. *pp.* 769–810, *Nov.* 22, 1928.

An account is given of the results of the measurements at the Phys.-Techn. Reichsanstalt on the five new and the five old resistance tubes hitherto used. The mean value M of the resistance of the 10 ohm is 1·001778. If two tubes which differ slightly from the rest are omitted M = 1·001778. This value is about $3 \cdot 3 \times 10^{-5}$ greater than the hitherto assumed M = 1·001745 got from the first ohm tube measurements in the years 1892 and 1893. The new determination of the international ohm in the Phys.-Techn. Reichsanstalt agrees within about 1×10^{-5} with the value obtained in the two last English determinations in the years 1912 and 1925. A better agreement than this cannot be expected. J. J. S.

943. Electric Conductivity and Optical Absorption of Metals. E. H. Hall. *Nat. Acad. Sci., Proc.* 14. *pp.* 802–811, *Oct.*, 1928.

The argument is examined that the known optical properties of metals require us to suppose the existence within them of free electrons as numerous as the atoms of the metal, using in turn three hypotheses as to the mechanism of conduction. Hypotheses A and B, that the current is maintained entirely by free electrons sharing and not sharing the energy of thermal agitation, are shown to involve the above conclusion. Hypothesis C, the dual theory of conduction, is found to be consistent with the observed optical properties of metals without involving a number of free electrons comparable with the number of atoms in the metal. W. S. S.

944. Effect of Cold Working on Conductivity. M. Masima and G. Sachs. *Zeits. f. Phys.* 51. 5–6. *pp.* 321–327, 1928.

Studies the alterations in the electrical conductivity of brass monocrystals containing 72 % by weight of copper when stretched. Curves were obtained showing the relation between the electrical and mechanical resistance of three different crystals for equal reductions in sectional area. The two sets of curves are in no way similar to one another; the electrical resistance changes suddenly when slipping ceases on one slip plane and commences on another; at these points the resistance to slip does not greatly alter. The behaviour of the crystals is somewhat complicated, and is being further investigated. The effect of annealing from different temperatures on the electrical conductivity has been investigated and compared with the alteration of the hardness as determined by pressing the surface with a hardened sphere. The curves are quite different, and the electrical conductivity alters very little with recrystallisation; even the vaporisation of zinc at 850° has little influence on the conductivity. The relation between electrical conductivity and temperature was studied for a stretched and an unstretched crystal; the increase in resistance due to stretching remains almost exactly the same for temperature between 20° and − 185° C. H. N. A.

945. Electrical Conductivity of Metals as a Function of Pressure according to the Sommerfeld Electron Theory. A. T. Waterman. *Phil. Mag.* 6. *pp.* 965–970, *Nov.*, 1928.

By recognition of the wave nature of the electron, Houston has worked out the dependence of the mean free path upon temperature, pressure, and other variables, thus contributing to Sommerfeld's theory of electrical conductivity. The results show fair agreement with experimental values. The formula for the pressure coefficient of resistance in the case of the effect of hydrostatic pressure on the conductivity of metals, as given by Houston, only gives results of the right order of magnitude, and due to the accuracy of Bridgman's data for the pressure coefficients of metals a more exact formula is warranted. The paper is an attempt to deduce such a formula. It is finally shown that an expression for the pressure coefficient of resistance can be deduced and a table sets forth the results. The present method apparently does not account for the positive value of the coefficient for lithium, and a possible explanation is put forward.

S. G. B.

946. Variation of the Resistivity of Thin Layers of Platinum. A. Féry. *Comptes Rendus*, 187. *pp.* 819–821, *Nov.* 5, 1928.

Continuing his investigation of the behaviour of Pt [see Abstract 1698 (1928)] the author finds that beyond 287 mμ in thickness the metal may be considered as "massive." But it is no longer ordinary Pt. Its resistivity, $4 \cdot 19 \times 10^{-4}$ ohm/cm., is forty times higher than that of ordinary Pt. It has, moreover, the blackish appearance which has given the name to platinum black. The highest microscopic enlargements give no appearance of graining. On heating the deposits after they are produced in the relative vacuum their resistance changes. At first it increases in a reversible way as the temperature rises. Then at a certain limiting temperature the resistance varies at constant temperature irreversibly and continually decreases towards a limit. This threshold of temperature varies with the thickness of the layer when this has not reached the value corresponding to the massive metal. Otherwise it is constant. In this case the limit is about 140° C. For small thicknesses it is lower. The limiting resistance towards which the deposits tend seems to depend on the constant temperature at which the operation is carried out. It diminishes when this temperature increases. On raising the temperature the evolution of the resistivity is accelerated, and at 340° C. it is practically at an end in 24 hours. Then the resistivity is within the limits assigned to Pt in the tables. If the tube is heated to 300° C. *during* the discharge the deposit formed has the white and brilliant appearance of ordinary Pt. It appears that there exist numerous intermediate forms between the two varieties of deposit—the black and the brilliant.

J. J. S.

947. Conductivity of Strong Electrolytes for High-Frequency Currents. H. Zahn. *Zeits. f. Phys.* 51. 5–6. *pp.* 350–354, 1928.

The conductivities of different electrolytes are compared, using high-frequency currents ($\lambda = 1$ m.), by means of a decrement method; the damping produced by eddy currents is greater the higher the conductivity of the electrolyte contained in a thin glass vessel, which is placed in a ring of copper wire, the ends of which are connected to two parallel wires in which the short wave-length oscillations are set up. The ratio between the conductivity of KCl solutions, and that of $MgSo_4$ and of $CuSO_4$ solutions is, in the concentration range investigated, different from that measured at low frequency. The differences agree satisfactorily with those calculated from the theory of Debye and Falkenhagen.

H. N. A.

948. Theoretical Significance of the Dependence of the Conductivity of Electrolytes on Potential and Frequency. G. Joos. *Phys. Zeits.* 29. *pp.* 755–760; *Disc.*, 769–770, *Nov.* 1, 1928. *Paper read before the Deut. Naturforscher u. Ärzte, Hamburg, Sept.*, 1928.

The theoretical significance of the dependence of the conductivity of electrolytes on potential and frequency and its bearing on the theory of solutions is discussed. The importance of the relaxation time is pointed out, and the results obtained from the Debye-Hueckel equation are contrasted with the Debye-Falkenhagen equation for the formation of the ionic atmosphere. F. J. B.

949. Structure of Electrolytic Solutions. Deviation of Electrolytes from Ohm's Law. M. Wien. *Phys. Zeits.* 29. *pp.* 751–755, *Nov.* 1, 1928. *Paper read before the Deut. Naturforscher u. Ärzte, Hamburg, Sept.*, 1928.

The change of conductivity with the concentration as shown by the work of Kohlrausch is discussed. The deviation of the results from the theoretical results are pointed out. A method of determining the conductivity with different frequencies and field strength was developed. It was found that the electrical conductivity of electrolytes increased with the strength of the field. In fields of moderate strength the increase is proportional to the square of the field. In very high fields the conductivity tends to reach a limiting value, and the limit is reached earlier the greater the dilution. The limit agrees with the conductivity at infinite dilution within the experimental error. If the field is at right angles to the current used for the conductivity measurement, no increase of conductivity is obtained. F. J. B.

950. Electrical Conductivity of Deformed Rock-Salt Crystals. Z. Gyulai and D. Hartly. *Zeits. f. Phys.* 51. 5–6. *pp.* 378–387, 1928.

The method employed for the investigation of the effect of pressure or sudden impact in a single direction on the physical properties of rock-salt crystals consisted essentially of a lever arm on one end of which could be hung weights of different values, which conveyed to the other end a movement submitting the crystal placed against it to a definite pressure. The electrical conductivity and the density were measured. It is found that the pressure creates an increase of the conductivity of the crystal which gradually diminishes with time. If a crystal has once been subjected to pressure, then in any subsequent subjection to the similar forces the conductivity shows a close relationship to the density. If the time of compression has been too small, in the first instance, to allow the density due to compression to come up to its equilibrium value, then the crystal is not fully compressed, and at a subsequent compression the conductivity will show a sudden increase as before. For the evolution of the full compression several seconds are necessary. The mechanical alteration, as observed microscopically, shows a tendency to sudden rearrangement. S. G. B.

951. Degree of Association in Fluid Dielectrics. M. Wolfke. *Phys. Zeits.* 29. *pp.* 713–716, *Oct.* 15, 1928.

The paper confines itself to the consideration of simple association, and derives a formula for the degree of association η from statistical considerations. This is used to calculate the values of η for solutions of different concentrations of ethyl ether, chlorobenzole, chinoline and nitrobenzole in benzole, and the results are compared in a table, and by means of graphs, with those obtained experimentally; the agreement is satisfactory, and for $C_4H_{10}O$ and C_6H_5Cl very good indeed. H. N. A.

952. Measurement at Radio Frequency of the Conductivity of Liquids without Immersed Electrodes. W. F. Powers and M. F. Dull. *J.O.S.A. and R.S.I.* 17. *pp.* 323–325, *Oct.*, 1928.

Burton and Pitt described a method for the above [see Abstract 2186 (1928)], using an oscillating valve. The present authors use a circuit in which a test-tube containing the liquid is inserted in a coil connected in the grid circuit of a non-oscillating valve, but which is coupled to a separate oscillator. A test frequency of about 600 kilocycles per second is used, and the dimensions of the coil, etc., are stated. An empty test-tube inserted in the coil will also affect the balance, and the authors conclude that both the permittivity and the conductivity of materials within the coil are of consequence. E. H. W. B.

953. Electrical Conduction and Discharge in Dielectric Liquids. A. Nikuradse. *Phys. Zeits.* 29. *pp.* 778–781, *Nov.*, 1928. *Paper read before the Deut. Naturforscher u. Ärzte, Hamburg, Sept.*, 1928.

An investigation of the relationship between the current and voltage behaviour of dielectrics. The voltage was carried up to the breakdown of the dielectric, and the behaviour immediately before the breakdown was observed. The connection between conductivity, viscosity, temperature pressure and breakdown voltage was determined. The conductivity is shown to be independent of the pressure between the limits of 3 and 760 mm., but the breakdown voltage increased with the pressure. The conductivity and the breakdown voltage increased with the temperature. In highly purified mineral oils, such as transformer oils, the ionic constant at spontaneous ionisation was determined. F. J. B.

954. Measurement of the Dielectric Constants of Liquids at High Electrical Field Strengths. J. Malsch. *Phys. Zeits.* 29. *pp.* 770–777, *Nov.* 1, 1928. *Paper read before the Deut. Naturforscher u. Ärzte, Hamburg, Sept.*, 1928.

A method of determining the dielectric constants of liquids at high field strengths was described in a previous communication [see Abstract 1039 (1928)]. The work was continued, and the dependence of the dielectric constant on the field strength was investigated for water, nitrobenzene, and alcohol. It is shown that the results are in accord with the Debye theory, and that the change is greater the smaller the dielectric constant, so that from the standpoint of the theory of dipoles, association phenomena must be excluded. F. J. B.

955. Suitability of the Resonance Method for Measuring the Dielectric Constants of Conducting Fluids. H. Kniepkamp. *Zeits. f. Phys.* 51. 1–2. *pp.* 95–107, 1928.

Investigates the action of an inductionless shunt to the capacity on the adjustment for current resonance and voltage resonance in an oscillating circuit. When current resonance is brought about by varying the capacity, the adjustment depends on the shunt to the capacity; this is theoretically not the case for voltage resonance, and experiments have confirmed this. It follows that in measuring the dielectric constant of a conducting fluid it is advantageous to use the voltage method. Measurements have been made of the dielectric constants of weakly conducting solutions of cane-sugar and of urea, at different concentrations, using a wave-length of 530 m., which confirm this conclusion. H. N. A.

956. Dielectric Constant of Emulsions of Mercury and Water in Oil. A. Piekara. *Acad. Polonaise Sci. et Lettres, Bull.* 6–7*a*. *pp.* 201–222, *June–July*, 1928. *In French.*

The dielectric constant depends upon the volumetric concentration much more than the formula of Lorenz and Lorentz would indicate, and besides, the relation is not approximately linear. It also depends more upon the dielectric constant of the dispersed component than that formula would indicate. The dielectric constant of the emulsion is also a function of the size of the droplets, which has hitherto escaped notice. Movement of the droplets has also a certain amount of influence on the dielectric constant of the emulsion. A. D.

957. Dispersion of Air and Carbon Dioxide in the Wave-Length Interval 600 down to 60 m. M. Forró. *Zeits. f. Phys.* 51. 5–6. *pp.* 374–377, 1928.

The alteration of the dielectric constants of air and carbon dioxide with wave-length was investigated over the interval 600 to 60 metres. Both gases showed a small increase with decreasing value of wave-length. The method employed was similar to that of a previous paper by the same author [see Abstract 1391 (1928)]. The results are set out in tabular form. S. G. B.

958. Gutton and Clément's Tests on the Dielectric Properties of Ionised Gases. J. Rybner. *Onde Élec.* 7. *pp.* 428–436, *Oct.*, 1928.

Gutton and Clément made experiments with air and hydrogen, and explained their results by supposing that the ions were not free and that their movements were controlled by quasi-elastic forces. The author considers this view is in conflict with the kinetic theory of gases, and he shows that the results can be explained quite satisfactorily by classical views regarding free ions. R. S. R.

959. Temperature Dependence of the Dielectric Constants of Gases and Vapours. Part II. H. A. Stuart. *Zeits. f. Phys.* 51. 7–8. *pp.* 490–510, 1928.

In a previous paper [see Abstract 1706 (1928)] measurements were recorded for carbon dioxide and air, and the present investigation gives similar data for the vapours of ethyl and methyl ethers, ethylene oxide, and acetone by means of a suitably modified apparatus, between the room-temperature and 180°. The following values were found for the electric moments: $(C_2H_5)_2O$, $1 \cdot 14 \times 10^{-18}$; $(CH_3)_2O$, $1 \cdot 29 \times 10^{-18}$; C_2H_4O, $1 \cdot 88 \times 10^{-18}$; and C_3H_6O, $2 \cdot 84 \times 10^{-18}$. The electrical moment of the water molecule is found to be $1 \cdot 79 \times 10^{-18}$ from the measurements of C. T. Zahn (*Phys Zeits.* 20. 15, 1919). Finally, the molecular models of methyl and ethyl ethers are discussed from the standpoint of the connection between the electrical charge distribution of the molecule, association, and the van der Waals constants. H. H. Ho.

960. Dielectric Constants in Electrostatic Fields. M. Jeżewski. *Zeits. f. Phys.* 51. 1–2. *pp.* 159–164, 1928.

Measurements were carried out of the dielectric constants of *p* azoxyphenetol and *p*-azoxyanisol in nematic phases, as they are called by Friedel (liquid crystals), in electrostatic fields from 0 to about 1000 volts/cm. A diminution of the dielectric constants was found to take place, which increased with the intensity of the field and tended asymptotically to a limiting value. J. J. S.

961. Maxwell-Thomson Method of Determination of Absolute Capacity. R. Skancke. *Zeits. f. Instrumentenk.* 48. *pp.* 432–438, *Sept.*, 1928.

In carrying out the measurement of capacity by Maxwell's method a difficulty occurs in obtaining a trustworthy interrupter with an absolutely constant periodic frequency, and there is need in high-frequency work for an arrangement giving surer execution of the measurement. With help of the newer technical appliances, especially the strengthened tubes, the difficulty of the interrupter can be overcome, and in the present paper two forms of arrangement of the interrupter are described which are suitable for the purpose in view and have the advantage of being cheap and easily installed. These arrangements are called the " vibration relay " and the " phonic wheel with interrupter." J. J. S.

962. Influence of a Magnetic Field on the Dielectric Constant. J. J. Weigle. *Helv. Phys. Acta.* 1. 4. *pp.* 273–275, 1928. *In French.*

Calculates the influence of a magnetic field on the dielectric constant of a gas the molecules of which have an electric moment perpendicular to a magnetic moment; the effect is negligible for such magnetic fields as can be obtained experimentally. For a molecule similar to NO and for the dielectric constant measured perpendicularly to the magnetic field the effect was again negligible. A. D.

963. Dielectric Anisotropy. M. Jeżewski. *Zeits. f. Phys.* 52. 3–4. *pp.* 268–274, 1928.

In a magnetic field where the lines of magnetic force are parallel to the electric lines, the dielectric constant of a nematic fluid is smaller, and when the magnetic field is at right angles to the electric it is greater than it is in the absence of the magnetic field. Disturbances of this law can be traced to the orienting effect of the walls and the capacity of the condenser. A. D.

964. Surface Electric Layer of Metals. J. Frenkel. *Zeits. f. Phys.* 51. 3–4. *pp.* 232–238, 1928.

From a consideration of the principles of wave mechanics and of the Fermi gas theory, the author modernises his previous representation of the surface electric double layer of metal bodies [see Abstract 543 (1917)]. The theory developed is, however, only qualitatively valid. From a critical examination of the principles involved, it is suggested that the sudden potential change in the double layer should be experimentally obtained from a comparison of the work required to eject electrons and protons from the same metal. This should give the required quantitative proof of the theory. R. C. F.

965. Observation and Recording of Changes of Thickness in Thin Wires. W. W. Loebe and C. Samson. *Zeits. f. techn. Phys.* 9. 10. *pp.* 414–419, 1928.

A method of observing and recording the changes in the diameter of thin wires is described. The method is continuous, and depends upon the variation in capacity of a condenser, which is varied as the diameter of the wire changes. A record of the changes in the diameter of the wire is obtained by the amplification of the capacity changes with a transformer. Details and curves of the variation of tungsten wire 25 μ thick are given. F. J. B.

966. Thermoelectric Power of Wires Partially Coated with a Foreign Metal. A. Kohaut. *Akad. Wiss. Wien, Ber.* 137. 2*a. No.* 7. *pp.* 463–467, 1928.

It was found that a partially tinned nickel wire acts as a thermoelement if the ends of the tin coating are heated to different temperatures. Quantitative measurements of the thermoelectric effect were carried out, using a constantan wire 2 m. long, coated over 50 cm. with electrolytic copper, one "junction" being kept at 100° C., the other at 18° C. The thermo e.m.f. was found to increase with decreasing resistance of the copper coating. The measured values are in good agreement with those calculated from the equation $e = 30(W_s/W_{cu}) \cdot 10^{-4}$, where W_s is the sum of the resistances of the copper coating and the constantan core, and W_{cu} is the resistance of the copper coating. L. L. B.

967. Screened Impedances. R. M. Wilmotte. *Phil. Mag.* 6. *pp.* 788–795, *Nov.*, 1928. *Supplement.*

For accurate measurements, especially at high frequencies, all impedances and apparatus used must be surrounded by metal screens kept at definite potentials. Thus, the leakage and capacity effects to earth can be rendered perfectly definite and the apparatus electrically independent of surrounding objects. Still, a question arises as to the value of the impedance of the apparatus. The impedance is the ratio of the potential difference across the apparatus to the current; but both of these depend on the potential of the screen, and the current may be measured at various points. One of the most usual values of the impedance is obtained when the screen is kept at the same potential as the terminal where the current is measured, but is not directly connected to that terminal. Then two possible values of impedance would naturally be expected, depending on which terminal is kept at the potential of the screen. In this paper a mathematical discussion is given of a general theorem on screened impedances, and the curious result is obtained that these two values are equal. Certain limitations are considered. This general result is of considerable importance, as it makes it unnecessary to connect the apparatus in any special way so long as the screen is kept at the same potential as the terminal at which the current is measured. J. J. S.

968. Characteristics of Alkali Cells and their Importance in Photoelectric Methods of Measurement. R. Fleischer and H. Goldschmidt. *Phys. Zeits.* 29. *pp.* 691–698, *Oct.* 1, 1928.

Discusses the theory of the method in which the illuminated photoelectric cell is made to discharge an electrometer. It is shown that the slopes of the current-voltage characteristics of alkali cells generally depend on the frequency of the light falling on the cell. Unless this relation is taken into account no satisfactory and comparable results can be obtained, and this is particularly the case when lights of different colours are employed. The simplest method to adopt in making measurements by the electrometer discharge method is to use cells whose current voltage curves in the saturation region are parallel to the axis of abscissæ (voltage axis). A cell which had been highly evacuated was found to have this property.

H. N. A.

969. Use of Selenium Cells for Registering the Potential Fall of Quadrant Electrometers. J. Scholz. *Phys. Zeits.* 29. *pp.* 702–705, *Oct.* 1, 1928.

Two similar selenium cells are employed, which are connected with a differentially polarised relay which governs the connections to the quadrant electrometer; the beam of light is thrown from one cell to the other at the proper moments by the mirror of the electrometer. At the same time the changes of the relay are recorded on a chronograph. Details of the adjustments which are required in using the method are given. H. N. A.

970. Intensitometer for the Measurement of Radiation Intensity over a Wide Range of Wave-Lengths (0·02–3 Å.). O. Glasser and V. B. Seitz. *J.O.S.A. and R.S.I.* 17. *pp.* 240–247, *Sept.*, 1928.

An apparatus for measuring radiation intensity over a wide range of wave-lengths is described. This apparatus consists of two parts: (1) a condenser unit to which an ionisation chamber is attached; and (2) an improved type of string electrometer, including a static charger. The condenser unit, with the electrometer attached, can be charged to a known potential, after which it is removed and placed with its ionisation chamber in the field of radiation which is to be measured. After the chamber has been exposed for a specified length of time, the condenser unit with the attached ionisation chamber is again connected with the electrometer and the loss of charge is directly read on the scale. This loss of charge can be converted into *r* units if the material from which the ionisation chamber is constructed and the size of the chamber are properly selected and if the electrical factors of the instrument are known. Radiation intensities for the range of wave-lengths from 0·02 to 3 Å. measured with this instrument are given. AUTHORS.

971. Ballistic Method of Ionisation Measurement with a Quadrant Electrometer. D. L. Webster and R. M. Yeatman. *J.O.S.A. and R.S.I.* 17. *pp.* 248–253, *Sept.*, 1928.

In the ballistic use of an electrometer for ionisation measurements the chamber is exposed to rays for a predetermined time, and the reading ordinarily taken is that of the electrometer after it stops swinging. The present method, more strictly ballistic, is to read the farthest point of swing. This not only saves time, but avoids serious complications from insulation leakage. The validity of this method depends on four conditions: (1) linearity of the differential equation of motion; (2) its homogeneity, except for the term proportional to the ionisation; (3) initial conditions, deflection and velocity zero; (4) constancy of exposure time. (4) is readily satisfied; (3) and (2) demand cancellation of natural ionisation by a constant opposite current; (1) is the most questionable. The present tests, on an electrometer having a period of 12 seconds with exposures from 2 to 40 seconds, demonstrate the possibility of satisfying all these conditions, so that the strictly ballistic method has no systematic errors large enough to detect in the presence of a 1 % erratic error. For large deflections, ballistic applications of a potentiometer show departures

of about 1 % from linearity, but even then calibration by the potentiometer enables this electrometer to compare ionisation currents accurately.
AUTHORS.

972. Absolute Electrometer. C. Snow. *Dept. of Commerce, Bureau of Standards, Research Paper No.* 17. *pp.* 513–530, 1928.

Considers the theory of the electrometer with special reference to an instrument for measurements up to 250,000 volts, where it is necessary to use spacings up to 110 cm. and, therefore, a comparatively small ratio of plate diameter to separation. An approximate formula is obtained for the electrical force acting upon a thick circular disc of about 5 cm. in radius when it hangs slightly displaced from the plane of its guard-ring and has a clearance of about 0·5 mm. The movable plate may be from 1 to 100 cm. below. In order to obtain a sufficiently uniform flux distribution over the disc under such conditions, a set of equal, concentric and equally spaced hoops (of radius equal to that of the disc) are arranged below the guard-ring, and each hoop is maintained at the potential which would be found at its position were the hoops absent and the discs infinite in radius. The effect of these hoops is treated theoretically in one section of the paper, and it is concluded that such an arrangement gives practically perfect compensation for the disc size provided the hoops can be maintained at the correct potentials.
J. W. T. W.

973. Theory of Einthoven String Galvanometer. W. A. Versluys. *K. Akad. Amsterdam, Proc.* 31. 7. *pp.* 670–678, 1928.

A theoretical treatment of the damped vibrations of a string vibrating in a homogeneous field of force. Numerical values obtained by putting in the constants of an Einthoven string galvanometer agree well with experimental values when the self-induction is taken into account.
W. H. GE.

974. Vibration Galvanometer observed Stroboscopically. J. B. Saunders. *J.O.S.A. and R.S.I.* 17. *pp.* 326–327, *Oct.*, 1928.

The vibration galvanometer used as a null indicator does not show if the setting of the particular network is too high or too low. Two methods of showing this are described, one using a sector disc and the other a neon lamp. The first method requires a rotating stroboscopic disc driven synchronously with the test supply. When the circuit is unbalanced the spot of light transmitted through the disc will appear stationary on one side or the other of a zero position, depending on whether the resistance in the variable arm is too high or too low. The neon tube method requires the lamp energised from the same source as the bridge supply, and thus a fixed synchronisation is attained.
E. H. W. B.

975. Method for Determining the Constants of an Electromagnetic Oscillograph. A. E. Kennelly. *Am. Phil. Soc., Proc.* 67. 2. *pp.* 123–128, 1928.

The three characteristic constants of an oscillograph, from which its behaviour at any or all frequencies is completely determinable, are: (1) its resonant frequency; (2) its " specific deflection," usually expressed in mm. of scale deflection, per r.m.s. ampere of single-frequency alternating current, taken at some convenient frequency of reference, such as the " initial " frequency, or a relatively low frequency, such as 60 cycles per second; (3) its "bluntness of resonance," B_0 or B_s, this being a simple numeric, the reciprocal of its sharpness of resonance. B_0 is its bluntness to decaying oscillations and B_s to sustained oscillations. B_0 is just half of B_s. There is ordinarily no difficulty in finding the specific deflection at a low frequency. The difficulty is to find the resonant frequency, since the maximum specific deflection is not obtained at the resonant frequency, but at the "maximum admittance" frequency, which may be very different. The resonant frequency may be found by the following method. A curve is obtained connecting specific deflection with frequency, the curve extending beyond the maximum. The observations are plotted on semi-log paper. The ordinates of this curve are then multiplied by the corresponding abscissæ and the new numbers are used to plot the angular-velocity curve, which is the resonance curve of the instrument. Plotted on semi-log paper, this curve should be symmetrical about its maximum ordinate, which locates the resonant frequency. The value of B_s is then easily determined, and from this and the known resonant frequency any observed deflection at a given frequency can be reduced to the magnitude and phase obtainable at the initial frequency. A. W.

976. Ammeter for Measuring Alternating Currents of Very High Frequency. E. B. Moullin. *Roy. Soc., Proc.* 121. *pp.* 41–71, *Nov.* 1, 1928.

The author explains in detail the method by which a fine wire thermal ammeter may be constructed in order to make very small the frequency correction which exists for other forms of ammeter when measuring currents of high frequency. The methods used to overcome difficulties arising from non-uniform current distribution in a conductor, the current distributing along a parallel wire system and the effects of external surrounding objects and fields are explained. Diagrams of longitudinal and transverse sections of the apparatus are given, and a full description of it. Calibration curves obtained show that currents may be measured to 0·5 %. R. S. R.

ALTERNATING CURRENTS AND MAGNETISM.

977. Heaviside's Formulæ for Alternating Currents. T. J. I'a Bromwich. *Phil. Mag.* 6. *pp.* 842–854, *Nov.*, 1928. *Supplement.*

A mathematical discussion with proofs of Heaviside's formulæ for alternating currents in cylindrical wires. J. J. S.

978. Purely Electrical Method of Finding the Form Factor of A.C. Voltages. H. König. *Helv. Phys. Acta,* 1. 4. *pp.* 293–296, 1928.

A triode valve is required which, for a certain heating current and a certain anode voltage, will give a graph for the relation between the grid current and the grid voltage which is nearly a straight line. Such a relation can be obtained with most triode valves, which then show infinite resistance in one direction and practically constant resistance in the other, so that the half-wave of current let through corresponds to the voltage curve investigated. The paper gives a diagram of connections, showing how the valve is connected to the compensation apparatus and galvanometer. The error due to the rounding off of the grid current voltage curve at the lower end was about 0·5 per 1000, which can be allowed for. A small auxiliary voltage can be used to bring the rectilinear part of the graph into such a position that when produced it passes through the zero point. H. N. A.

979. Magnetic Field Strength in the Plane of a Circle Carrying a Current. L. Fleischmann. *Arch. f. Elektrot.* 21. *pp.* 30–34, *Oct.* 22, 1928.

Simple formulæ for the magnetic field strength at the centre of a current-carrying circle of wire and for points on the axis drawn through the centre normally to the plane of the circle are well known and can be readily obtained by elementary principles. The field strength at other points in the plane of the circle, however, is usually calculated from the vector potential of the circuit, involving somewhat advanced electromagnetic theory. The paper shows how the calculation may be made from simple geometrical principles, leading to the usual elliptic function expression for the magnetic force. The formula is compared with the results of an experimental exploration of the field of a circular turn, using a ballistic method. Finally, the formula is integrated to give an expression for the mutual inductance between two concentric circles lying in the same plane, the result being expressed in terms of elliptic functions. B. H.

980. Effect of Repeated Stresses on the Magnetic Properties of Steel. M. F. Fischer. *Dept. of Commerce, Bureau of Standards, Research Paper No.* 26. *pp.* 721–732, 1928.

Changes in the magnetic properties of steel generally accompany changes in the other physical characteristics. This suggests the possibility of detecting and following the progress of a fatigue crack by magnetic methods. It was found, however, that the magnetic changes produced by repeated stresses above the endurance limit are not of a type which can be associated with the characteristic effect of a crack transverse to the direction of magnetisation. The similarity of the observed magnetic changes with those brought about by the removal of externally applied static stresses indicates that the observed changes may be produced by the partial relief or redistribution of initially existing internal stresses. The fact that the magnetic changes brought about by understressing are of a similar character though less in magnitude suggests that some of the beneficial effect of understressing may be due to partial stress relief. AUTHOR.

981. Magnetic Hysteresis at High Frequencies. W. Neumann. *Zeits. f. Phys.* 51. 5–6. *pp.* 355–373, 1928.

Two kinds of iron—namely, Swedish steel and 50 % iron-nickel alloy made by Krupp—were subjected to alternating magnetisation of frequencies between 500, 1500 and 2550 cycles, and the hysteresis curves were found point by point. A comparison of the results obtained with those of the statistical curves showed with increasing frequency a tendency for an increased remanence of the magnetisation behind the statistical values. The increase of the hysteresis losses were as follows: Swedish steel, about 3 % at 500 and between 8 and 9 % at 2550 Hertz cycles; iron-nickel 50 % alloy, about 20 % at 500 and 60 % at 1500 Hertz cycles. To a rough approximation it can be said that for a given kind of iron sample the apparent increase of coercive force is proportional to the maximum rate of increase of magnetisation, and is independent of the field amplitude and the frequency. Full experimental details are given. S. G. B.

982. Change of Magnetisation Intensity of an Iron Wire under Tension. J. B. Seth, C. Anand and M. Dayal. *Zeits. f. Phys.* 52. 5–6. *pp.* 382–388, 1928.

Experiments are described in which iron wire is subjected to different weak magnetic fields during which its state of tension is altered, the resulting change in magnetisation intensity being followed by means of a ballistic differential method. The curves showing the relationship between intensity and extension are very similar to each other for the different fields and also to the extension tension curves obtained by loading the wire. H. H. Ho.

983. Atomic Moments. P. Weiss and G. Foëx. *Comptes Rendus,* 187. *pp.* 744–746, *Oct.* 29, 1928.

Atomic moments in magnetons, as found by various investigators, are given for a number of substances. The values have been corrected, not only for the diamagnetism of the atoms combined with the particular one considered, but also for that of the atom itself. The moments approximate in nearly all cases to whole numbers, the exceptions being Co″ in the hexagonal sulphate and Fe″ in the ferrous ammonium sulphate. All the moments are rational fractions of Bohr's theoretical magneton. G. E. A.

984. Barkhausen Effect. J. Pfaffenberger. *Ann. d. Physik,* 87. 6. *pp.* 737–768, *Nov.* 22, 1928.

Barkhausen has shown that ferromagnetic material in an increasing magnetic field exhibits irregular increases in induction which can be detected acoustically or by a galvanometer [see Abstract 443 (1920)]. Van der Pol found that the effect took place on the steep part of the magnetisation curve, whilst Adelsberger noted the liberation of heat under a similar condition [see Abstract 2769 (1927)]. The author has investigated the quantitative distribution of the effect along the hysteresis curve. Bundles of thin wires of steel, hard nickel and annealed nickel were first tested for coercive force, remanent induction and hysteresis heat. They were then subjected to a continuous change of field by slow motion towards a strong electromagnet, and the Barkhausen effect was derived from the current induced in a coil surrounding the specimen, which was led through an amplifier and transformer to a string galvanometer from which a photographic record was obtained. The magnitude and number of the "effects" are dependent on the rapidity of change of field, but the sum of the effect amplitudes is independent of this speed. Heat losses and Barkhausen effects are not parallel occurrences in nickel, although there is apparent similarity in their distribution. The length of a "coherence" region is about 3 millimetres. G. E. A.

985. Magnetism of Hydrated Zirconia. F. Bourion and (Miss) O. Hun. *Comptes Rendus,* 187. *pp.* 886–888, *Nov.* 12, 1928.

The susceptibility of hydrated zirconia is a linear function of the water-content down to about 5 %. It behaves like a mixture of water with a feebly paramagnetic dioxide; but this is no longer the case when the water-content has been reduced below 5 % by ignition, since the ignited oxide is diamagnetic. T. M. L.

986. Magnetic Susceptibility of Single Crystals of Zinc and Cadmium. J. C. McLennan, R. Ruedy and Elizabeth Cohen. *Roy. Soc., Proc.* 121. *pp.* 9–21, *Nov.* 1, 1928.

The metals Zn and Cd crystallise in the hexagonal system, and long crystals were obtained by lowering the molten metal slowly out of the furnace. The Gouy method was employed in determining the susceptibility, in which the specimen is weighed in the presence and absence of a strong magnetic field. For a direction parallel to the hexagonal axis the specific susceptibility, χ, of these metals is a maximum, and at right angles to the axis it is a minimum, the values found being

$$\text{Cd}, \ \chi \,\|\, 190\cdot 10^{-6}; \quad \chi \perp 145\cdot 10^{-6}$$
$$\text{Zn}, \ \chi \,\|\, 261\cdot 10^{-6}; \quad \chi \perp 160\cdot 10^{-6}$$

Observations with mercury solidified by being lowered slowly into a space cooled by liquid air indicate that this metal crystallises in a rhombohedral form. Reference is made to Pauli's theory of the magnetism of metals [see Abstract 1456 (1927)]. G. E. A.

987. Preliminary Results of Ocean Magnetic Observations on the "Carnegie" from Washington to Plymouth, Hamburg, and Reykjavik, May to July, 1928. J. P. Ault. *Terr. Mag.* 33. *pp.* 121–128, *Sept.*, 1928.

988. New Method of Marking Time on Magnetograms. H. E. McComb. *Terr. Mag.* 33. *pp.* 159–161, *Sept.*, 1928.

A new method of marking-time on magnetograms consists essentially in increasing the width of the slit in front of the light source for a few seconds each hour. The resulting marks are short, black lines on all base-lines and curves. The slits are cut in an extension of the armature of a very sensitive relay which is operated by an independent clock. AUTHOR.

989. Solar Activity and Terrestrial Magnetism. C. Maurain. *Onde Élec.* 7. *pp.* 413–427, *Oct.*, 1927.

The author first reviews the facts established regarding the frequency and movements of sunspots. An examination of magnetic records obtained near Paris indicates a diurnal variation with larger summer than winter values and a yearly change of the diurnal amplitude with the epochs of maximum and minimum number of sunspots. From a statistical examination large magnetic disturbances occur 2½ days after sunspot changes, but at sunspot minimum the delay is 3¾ days. Many large magnetic disturbances cannot be traced to visible sunspot changes. He considers that the magnetic changes are due to the arrival in the upper air from the sun of electrified particles. These will have an associated magnetic field during their movement and they increase the conductivity of the air and so increase the electric currents induced by atmospheric motion in the earth's magnetic field. The author also considers that the speed of the electrified particles may vary with the phase of solar activity. R. S. R.

RADIOGRAPHY AND ELECTROPHYSIOLOGY.

990. Some Effects of X-Radiation on the Blood. Part I. Measurement of Radiation. W. V. Mayneord. Part II. Effects on the Blood. A. Piney. *Brit. J. of Radiology*, 1. *pp.* 257–278, *Aug.*, 1928.

Part I.—It is important in experiments of the effects of X-rays on tissues to determine as accurately as possible the quality and quantity of the radiations employed. The first part of the paper consists of a description of the physical conditions of irradiation of the rabbits employed for the experiments, the animals being irradiated from below by means of a Coolidge tube at 90 kV peak, the radiation being practically unfiltered. The quality of the radiation was defined in terms of the absorption in aluminium ($\lambda_e = 0\cdot375$ Å.). The intensity of radiation was measured in electrostatic units (R) and found to be 19 R per minute without back-scatter. With secondary effects approximated 10 % must be added to this value for the conditions used. Doses ranging from 8000 R to 38 R were given to various animals, continuously and intermittently in different experiments. Experiments were made on a model rabbit consisting of a celluloid box filled with water and of the approximate dimensions of the animals. A small exploring ionisation chamber enabled measurements to be made at various points within the animal and hence an estimate to be made of the doses received by various organs (spleen, etc.) of particular interest. A diagram showing the distribution is given.

Part II.—It was found that exposure for seven hours (7920 R) resulted in an extreme degree of lymphocytopenia, which persisted until the animal died about three weeks later. During and immediately after the irradiation all forms of blood-cells decreased in number until, at the end of the dose, there were only about 600 leucocytes in the blood. At the end of 24 hours there was an extreme increase of neutrophiles, which persisted, though less intensely, until death. Monocytes rose in number until more numerous than lymphocytes, the persistence of this condition appearing to be a sign of impending death. Other rabbits behaved similarly. Using a smaller dose (approx. 500 R) it was found that if this dose were given in 24 minutes continuous irradiation there was a fall in lymphocytes which persisted for some 6 weeks after irradiation, but then the numbers returned to normal. Neutrophiles were excessive in number for three weeks after irradiation and then returned to normal. Using the same total dose but fractionated over 23 successive days, the changes appeared to be more intense and prolonged while the divided doses caused no change in monocytes though the single dose produced monocytosis for a few days. W. V. M.

991. International Congress of Radiology at Stockholm. W. E. Schall. *Brit. J. of Radiology*, 1. *pp.* 366–370, *Oct.*, 1928.

An account of some radiological problems and their solutions as demonstrated at the Stockholm Congress of Radiology, July, 1928. The importance of the international unit of dose (*r* unit) and the adoption of international standards of protection are emphasised. W. V. M.

992. Therapeutic Methods and Results at Radiumhemmet. G. Forssell. *Brit. J. of Radiology*, 1. *pp.* 374–377, *Oct.*, 1928.

A brief account of the radiotherapeutic work carried out in Stockholm

Radiumhemmet under the guidance of the writer. The organisation is first discussed, and it is pointed out that the Swedish Government defrays the travelling expenses of all poor patients, and hence makes it possible to keep constant track of cases. At first only inoperable tumours were treated with radium, but gradually, as technique improved, the field has been widened. The figures relating to results are given. Of the total of applicants of 207 cases of cancer of the skin of the face from the years 1910–1915, inclusive, an absolute cure of 68 %. Of operable cases, the figure for relative cure is 78 %. Of lip cancer the figure is 68 %, and operable 86 %. Results are given for cancer of the mouth, uterine cervix, and sarcoma. In those types of tumour that offer a fair chance of obtaining a primary healing by radiological treatment, the duration of the healing obtained by radiotherapy is, both as regards the relative and the absolute performance, in every way comparable to the results obtained by surgery. The percentage recurrences in most of the forms of tumour is lower than after primary surgical healing and in none of the groups is it higher. The writer finally discusses the palliative effects of radiation treatment. If only considering the 3354 cases in which radiological treatment only was carried out, primary local healing was obtained in 1714 cases. W. V. M.

993. Influence of Temperature on Response to Electrical Stimulation. H. H. Dixon and T. A. Bennet-Clark. *Roy. Dublin Soc., Proc.* 19. *pp.* 27–38, *Sept.*, 1928.

The evidence is discussed on which is based the belief that the electrical conductivity of a tissue is largely due to the permeability of the protoplasmic membranes of the component cells to ions, and that a change in conductivity is due to, and is proportional to, a change in the permeability of the protoplasts. A further study is described of the effects on the permeability (conductivity) of passing alternating currents through tissues, and it is shown that between November and March the sensitivity of the leaf of Hedera helix to electrical stimuli varies regularly over a very wide range. It is demonstrated that temperature exerts a much more marked effect on the magnitude of a response to a given stimulus than had been previously supposed; between 20° and 35° C. a change of 1° may alter the magnitude of the response as much as 10 %. The effect of temperature on the conductivity is described, and the question of the relation between the energy supplied to the tissue and the magnitude of the response is briefly discussed. W. V. M.

994. Efficiency of Prolonged Continuous Currents in Neuro-Muscular Excitation. P. Fabre. *Comptes Rendus*, 187. *pp.* 675–676, *Oct.* 15, 1928.

Weiss has enumerated a law of the form $Q = a + bt$ defining the intensity of current b necessary to excite a nerve. The author points out, for a lengthy application of a current below this limiting value, another effect enters into consideration, since the long-continued application causes a diminution of resistance of the living membranes, doubtless due to penetration of ions into the cell membranes and their accumulation, with resulting increase of conductivity and decrease of polarisation current. The curves representing the Weiss law and the author's kinetic theory of the action [see Abstract 315 (1929)] are discussed, and the former curve is a particular region of the latter. B. J. L.

CHEMICAL PHYSICS AND ELECTROCHEMISTRY.

995. Adsorption of Vapour on a Quartz or Glass Wall. A. Smits. *Chem. Soc., J. pp.* 2952–2954, *Nov.*, 1928.

The results of the author's experiments [see Abstract 879 (1929)] and those of other investigators indicate that the adsorption films on a mercury surface and on glass or quartz surfaces, as plane as possible, formed in almost saturated vapour, may consist of a large number of molecular layers. T. H. P.

996. Thickness of Adsorbed Vapour Films. G. H. Latham. *Am. Chem. Soc., J.* 50. *pp.* 2987–2997, *Nov.*, 1928.

The adsorption of vapour of water, toluene, nitromethane, and acetonitrile on glass and metallic surfaces was studied, continuing the work of McHaffie and Lenher and of Frazer, Patrick and Smith. The method consisted in measuring the pressure within a small glass bulb, exerted by a known amount of vapour at constant volume. The measurements were made over such a range of temperature that at the upper limit all of the substance would be in the gaseous condition, while at the lower limit some would be in the liquid state. The results showed that soft glass, which had been thoroughly melted and cooled without coming in contact with anything except dry air, must be considered as offering a plane surface for adsorption measurements, but acid-treated glass cannot be considered as plane from the standpoint of adsorption measurements. The thickness of the adsorbed vapour film on fire-polished glass surfaces was not essentially greater than unimolecular for either polar or non-polar substances. On acid-treated glass surfaces the thickness of the adsorbed film appears to be about fifty molecules for polar and non-polar substances. Platinum surfaces on which mercury had been deposited electrolytically, adsorb water vapour quite strongly. The thickness of the adsorbed film was about thirty molecules. Silver surfaces amalgamated electrolytically may be considered plane, and the thickness of the adsorbed water-vapour film was not greater than unimolecular. F. J. B.

997. Sorption of Carbon Tetrachloride at Low Pressures by Activated Charcoals. Part I. Apparatus and Method. R. Chaplin. *Roy. Soc., Proc.* 121. *pp.* 344–358, *Nov.* 1, 1928.

The experiments are made with the Pirani gauge as developed by N. Campbell and with charcoals of different origins, activated with air, steam or $ZnCl_2$, mostly at 25° and pressures ranging from $2 \cdot 3 \times 10^{-1}$ down to 1×10^{-4} mm. The method and calculations, the difficulties caused by traces of gases and vapours in the charcoals and the apparatus are described; details of results and discussion are to follow. H. B.

998. Invasion and Solvation of Gases in Water. G. M. Schwab and E. Berninger. *Zeits. f. phys. Chem.* 138. 1–2. *pp.* 55–74, *Oct.*, 1928.

Like Adeney and Becker [see Abstract 647 (1920)] the authors pass bubbles of various gases up a glass tube 1 m. in length, which is heated to 80° by a water-jacket and so mounted in a wooden frame that it can be turned in various directions; the capillary end is closed by a ground joint. The moving gas bubbles are observed by a microscope and are photographed. Calculations are made after Lewis and Whitman [see

Abstract 686 (1925)] on the assumption that the gas has to diffuse through a stationary film of gas and a liquid film in equilibrium at their boundary face. In the case of the little-soluble gases used, O_2, H_2, NO, CO_2, C_2H_4, and C_2H_2, the phenomena would essentially depend upon the very slow diffusion through the liquid film. The gases differ much as to their rates of solution and their temperature coefficients, even as regards the sign, but the invasion coefficients deduced are, for 20° C., nearly the same. The differences are ascribed to differences in the properties of the water shells, provisionally assumed to correspond to the number of molecules of hydration. The hydration increases in all cases with rising temperature, most markedly for CO_2 and C_2H_2. H. B.

999. Hydrolysis and Beer's Law. R. C. Gibbs and C. V. Shapiro. *Nat. Acad. Sci., Proc.* 14. *pp.* 694–700, *Sept.*, 1928.

Beer's law states that for a given thickness the extinction E, defined as log I_0/I, is proportional to the concentration. It is based on the assumption that no change occurs in the character of the absorbing centres as the concentration varies. Hydrolysis should affect the character of the absorbing centres, and is especially operative at low concentrations. The effect of hydrolysis has been investigated with phenolphthalene and resorcinol-benzene, varying the degree of hydrolysis by addition of excess KOH (alcoholic solutions were used). When a hundred times as much alkali as is necessary for salt formation was added to phenolphthalene, the character of the absorption was found to be independent of the concentration, showing that hydrolysis had been prevented, so that the curve obtained represented truly the absorption of the dibasic ion. With only ten times the amount of alkali necessary, the absorption was no longer independent of the concentration. With stronger acids, such as resorcinol-benzene, the effects were similar though less alkali was required. Similar results are quoted for other acidic deviations of triphenylmethane. It is pointed out that these experiments give the clue to the difficulty of reconciliating the observations of different workers who used different concentrations. A. C. M.

1000. Application of Temperature Gradient to Metallographic Investigations. O. Tesche. *Zeits. f. techn. Phys.* 9. 10. *pp.* 419–425, 1928.

A method was developed by means of which it is possible to investigate the properties of an alloy in rod form, and to follow the changes which take place when the rod is exposed to a range of temperature. A steel rod was heated at one end to temperature of 700° C., and the other end kept at a temperature of 100° C. Before heating, the steel (containing 0·9 % carbon) was hardened in water. After the heating, sections were cut parallel to the direction of temperature fall, polished and etched. From the microstructure a scale was constructed by means of which the heat treatment suitable for a definite degree of hardening could be ascertained. F. J. B.

1001. Structure of Some Ternary Alloys of Copper, Zinc and Aluminium. A. J. Bradley and C. H. Gregory. *Manchester Phil. Soc., Mem.* 72. *pp.* 91–100, 1927–1928.

The question of so-called intermetallic compounds is reviewed, and the evidence for their existence is criticised. A series of alloys of copper, zinc and aluminium was prepared and examined by the X-ray powder method, using a tube of hot-filament type. The results indicate that the term " solid solution in an intermetallic compound " is a misnomer, and the term " complex solid solution " is suggested as preferable. Ternary alloys of copper, zinc and aluminium made up from binary alloys of copper and zinc and copper and aluminium, both possessing the γ-structure, consist of homogeneous solid solutions with the same type of structure as the binary alloys. The similarity of these alloys is considered to be due to the concentration of the valency electrons being approximately the same in each case. F. J. B.

1002. Microscopic Studies of a " Passive " Layer on Carbon Steel and the resulting Etch Structure. C. Benedicks and P. Sederholm. *Zeits. f. phys. Chem.* 138. 1–2. *pp.* 123–134, *Oct.*, 1928.

The fact that a strong solution of nitric acid renders iron passive, whilst a much more dilute solution does not have this effect, is considered to be due to the lower degree of dissociation of the stronger acid, causing the attack of the acid to be much less on both the metal and the oxide layer which may be present. If this view is correct, a dilute solution of nitric acid should effect passivity if by some means the degree of dissociation is depressed. This can be accomplished by using an ethyl alcohol solution. Experiments have been made on the etching effects of a 0·1 % solution of nitric acid in alcohol, containing progressively increasing amounts of water, on a piece of Swedish tool steel containing 1·08 % carbon. Certain striking etching phenomena were observed, and the connection between these and the formation of a " passive " oxide layer is indicated. L. L. B.

1003. Theory of Metallic Corrosion in the Light of Quantitative Measurements. G. D. Bengough, J. M. Stuart and A. R. Lee. *Roy. Soc., Proc.* 121. *pp.* 88–121, *Nov.* 1, 1928.

Typical corrosion-time curves for annealed zinc in conductivity water and in a series of potassium chloride solutions under 1 atmosphere of oxygen pressure at 25° C. [see Abstract 501 (1928)] concave upwards, ranging from zero-time to two or three days, during which it is probable that a negative electrode potential is being built up at isolated positions in the metallic surface till it reaches a maximum fixed by the experimental conditions. This potential is closely connected with the local exclusion of oxygen from the metal surface by the accumulated corrosion products. The second branch, which may be either exponential or linear; the former is reached when the oxygen supply is ample, the main controlling factor being the rate of withdrawal of chlorine ions from the solution. At 760 mm. pressure such a condition obtains only in solutions weaker than about 0·001 *N*, even with vessels permitting a large gas-liquid interface and a depth of immersion of 1·5 cm. The straight-line type is realised when the oxygen is the controlling factor—*i.e.*, in solutions stronger than about 0·001 *N* in 12·5 cm. vessels—and occurs even when hydrogen is evolved. The final branches are approximately straight lines of slight inclination to the horizontal. Little or no hydrogen is displaced with solutions weaker than 0·00005 *N*, but the gas always appears with solutions more concentrated than 0·0001 *N*, except when highly purified zinc is used. The form of the gas evolution-time curves is explainable on the hypothesis that over-potential, as affected by metallic impurities, is the determining factor. The proportion of total corrosion due to this type is 5 to 15 % for 0·0001–0·1 *N* solutions. Total corrosion curves are not exponential, probably owing to the participation in the process of an ion other than chlorine ion. The total amount of corrosion for standard specimens in water of conductivity about 0·055 mho is only about 1 milligramme of zinc after 50 days. The total corrosion in potassium chloride solution up to the time when the corrosion-time curve is almost horizontal is independent of the oxygen-supply, but depends on the concentration of the solution and on the rate of withdrawal of chlorine atoms from current-carrying capacity either by precipitation or by implication in complex anions or otherwise. With gradual increase in concentration of the solution, corrosion rises to a maximum and afterwards falls. Newly turned or burnished surfaces give more variable and usually lower results than annealed surfaces. Annealing for a week at 250–260° C. leads to reasonably concordant results, the surface layers then showing a fine polyhedral structure. T. H. P.

1004. Influence of Pressure on Reaction Velocity. Rôle of the Medium in Homogeneous Liquid Systems. A. L. T. Moesveld and W. A. T. de Meester. *Zeits. f. phys. Chem.* 138. 3–4. *pp.* 169–225, *Nov.*, 1928.

The general theory of the effect of pressure on reaction velocities is discussed. The influence of pressure, up to 1500 atmospheres, on the inversion of cane sugar, the hydrolysis of methyl acetate, the saponification of a series of esters both aliphatic and aromatic, the interaction of bromic and hydrobromic acids, was determined in the presence of water and mixtures of various alcohols and water. A theory to explain the observed results is proposed. It demands the partial separation of the components of the medium which exert a deforming force on the dissolved molecules. The theory makes it possible to predict the effect of pressure on a reaction. Further work is outlined in order to extend the theory. F. J. B.

1005. Physico-Chemical Periodicity. N. v. Raschevsky. *Zeits. f. Phys.* 52. 5–6. *pp.* 372–381, 1928.

In this paper it is shown that a continuous reaction series which gives rise to an heterogeneous cell-like structure contains the possibility of a certain rhythm. The occurrence of this rhythm is independent, within wide limits, of the special character of the reaction sequence and the resultant structure. Special conditions are necessary for the presence of a real mathematical periodicity which refer to the physical structure of the initial member of the series. H. H. Ho.

1006. Relations between the Carbon, Hydrogen and Oxygen Content in Cotton Cellulose under Thermal Decomposition and its Weight Loss. T. Akahira. *Inst. Phys. and Chem. Research, Tokyo, Sci. Papers No.* 163. *pp.* 165–180, *Sept.* 28, 1928. *In English.*

Paper and cotton are used in the insulation of electrical apparatus which become heated owing to the energy losses, thus gradually decomposing by heat the insulating cellulosic material. In this research cotton is decomposed by heat under various heating conditions and the products analysed in terms of carbon, hydrogen and oxygen. The ratio of hydrogen to oxygen is found to be independent of the weight loss, *i.e.*, it is a constant and equal to that of the water molecule in the original cotton. J. K.

1007. Equilibrium between Hydrogen-Carbon Monoxide and Methane-Carbon Dioxide in the Corona Discharge. G. L. Wendt and G. M. Evans. *Am. Chem. Soc., J.* 50. *pp.* 2610–2621, *Oct.*, 1928.

Reference is made to many earlier workers [see Abstract 2179 (1927)]. In the present paper the discharge taking place between a central wire and a concentric cylinder is referred to as the corona and not to the discharge occurring in the ozoniser, where the discharge takes place between two concentric cylinders. It has been found that the reaction $2CO + 2H_2 = CO_2 + CH_4$ reaches an equilibrium when approached from either side when the composition is 13·3 % carbon dioxide, 37·1 % carbon monoxide, 8·7 % methane and 37·6 % hydrogen. Under purely thermal conditions this equilibrium corresponds to an absolute temperature of 900° to 950°. J. K.

1008. Thermal Decomposition of Ozone at Low Pressures. E. H. Riesenfeld and H. J. Schumacher. *Zeits. f. phys. Chem.* 138. 3–4. *pp.* 268–285, *Nov.*, 1928.

At the low concentrations corresponding with pressures between 6 and 60 mm., the decomposition of ozone by heat represents a reaction of the first order. At 95° C. the velocity constant of the reaction is $2 \cdot 5 \,.\, 10^{-3}$ litres per minute, and between 80° and 100° C. its temperature coefficient is 2·0 per 10°. When sufficiently purified, oxygen, argon, nitrogen and carbon dioxide influence the velocity of the monomolecular reaction either not at all or not appreciably. In all the experiments made, the bimolecular decomposition of ozone, which predominates at higher concentrations, exerts a manifest influence, which has to be allowed for by means of a correction term. The results confirm those of Riesenfeld and Bohnholtzer showing that the bimolecular decomposition of ozone is independent of the oxygen pressure; in this respect argon behaves similarly to oxygen, but admixture of nitrogen, and still more that of carbon dioxide, accelerate the bimolecular reaction. T. H. P.

1009. Formation of Iron Nitride in the Iron-Nitrogen Arc. E. J. B. Willey. *Chem. Soc., J. pp.* 2840–2844, *Nov.*, 1928.

Reference is made to an earlier paper [see Abstract 2707 (1928)] wherein it was shown that when an arc is burned between poles of iron in an atmosphere of nitrogen the deposit formed on the walls of the vessel contains about 2 % of iron nitride. Acting on a suggestion of Rideal, the present work verifies the supposition that the yield is greatly increased if the vapours are quickly removed from the high-temperature zone and chilled. Full experimental details are given. J. K.

1010. Catalytic Decomposition of Gaseous Acetaldehyde at Surface of various Metals. P. C. Allen and C. N. Hinshelwood. *Roy. Soc., Proc.* 121. *pp.* 141–155, *Nov.* 1, 1928.

It is pointed out that certain decompositions such as nitrous oxide and hydrogen iodide, bimolecular as homogeneous reactions become unimolecular when catalysed, a probable explanation being the capacity of metals to absorb many of the simple gases, thereby rendering possible a change such as $N_2O = N_2 + O$. The authors have now recorded their results on catalytically decomposing acetaldehyde, which as a gas reaction has been shown to be bimolecular [see Abstract 2227 (1926)], using electrically heated wires of gold, platinum, platinum-rhodium alloy and tungsten. There is complete departure from the simple second order which thus precludes the assumption of a purely gaseous reaction near the wire. It is pointed out, however, that there is an unusual lack of specificity in the different catalysts which suggests that the adsorption is feebler, less "chemical," than that involved in catalytic reactions of such gases as nitrous oxide. J. K.

1011. Sixth Report of the Committee on Contact Catalysis. R. E. Burk. *J. Phys. Chem.* 32. *pp.* 1601–1645, *Nov.*, 1928.

In addition to covering important new developments during the year, this report summarises the principal points of the five previous issues together with relevant work in other fields. Recent books are also briefly reviewed. The various sections deal with: Contact Catalysis and Reaction Velocity in General; Facilitation of Energy Transfer; Lowering of the Heat of Activation; Molecular Distortion Theory; The Nature of Chemical Bonds; Condition of Adsorbed Gases; Differential Heats of Adsorption; Amount of Adsorption and Catalytic Activity; Intermediate Compounds; Active Centres and the Structure of Surfaces; Promoter Action; Supported Catalysts; Films on Catalysts; Poisons; Dust Particles; Moisture; Negative Catalysis or Inhibitors; Homogeneous Catalysis; Heat of Reaction and Catalytic Mechanisms; Simultaneous Reactions; The Thermal Decomposition of Ammonia; The Decomposition of Hydrogen Peroxide; Water Synthesis; and Special Points. The final section is devoted to a collection of miscellaneous results which do not fit very well under the previous heads. The spirit of the report has been to systematise the results and to enumerate and evaluate, as far as possible, the various factors which could be expected to operate in catalysis. H. H. Ho.

1012. Causes and Prevention of Pitting in Electrodeposited Nickel. D. J. Macnaughtan and A. W. Hothersall. *Faraday Soc., Trans.* 24. *pp.* 497–509, *Oct.*, 1928.

Examples of pitting as obtained in deposits of nickel, iron, cobalt, zinc and copper are described. Differences are observed in the shape, internal lustre and distribution of the pits, and considerations of the probable causes of these differences are discussed. Observations of a magnified portion of the kathode surface during deposition indicate that a pit is produced in a nickel deposit either by a bubble of gas clinging to the kathode surface for a prolonged period during deposition, or by a succession of bubbles proceeding from a particular point on the kathode surface. When anodes and solutions of commercial purity are replaced by highly purified materials, it is found that pitting of the deposit is of less frequent occurrence and is localised above defects in the kathode surfaces where bubbles of gas formed and accumulated during deposition. The visual observation that a greater discharge of hydrogen occurs at a steel surface compared with a similar surface coated with electrodeposited copper is confirmed by kathode efficiency tests. The beneficial effect of the copper would appear to consist, not only in covering up these defects and thereby eliminating these areas of lower overvoltage, but also in providing a basis metal for nickel deposition upon which the overvoltage of hydrogen discharge is higher than upon steel. Determination of the solubility of hydrogen in nickel-depositing solutions indicates that a not inconsiderable amount of hydrogen may be evolved at the kathode surface during nickel deposition without appearing in the form of bubbles. In nickel deposition with anodes and solutions of ordinary commercial purity it is found that pitting occurs not only as a result of defects in the basis metal, but also as a consequence of a defective condition in the solution. The possibility of eliminating basis metal pitting on a kathode by means of a preliminary deposit of copper of a suitable thickness is described. J. N. P.

1013. Electrode Potential of Nickel. Part II. Effect of Occluded Hydrogen on the Electrode Potential of Nickel. K. Murata. *Chem. Soc. Japan, Bull.* 3. *pp.* 253–261, *Oct.*, 1928. *In English.*

According to the view of the author in his first paper [see Abstract 2528 (1928)], the occluded hydrogen in the freshly prepared nickel electrode led to accurately reversible and reproducible electrode potential. Schoch [see Abstract 750 (1909)], however, reported that occluded hydrogen in nickel gave an indefinite and abnormally lower potential. From the present detailed investigation the conclusion is reached that occluded hydrogen in nickel has no effect on the true electrode potential. What is found, however, to be the essential is the exclusion of oxygen. By working, therefore, in a hydrogen atmosphere this requirement is brought about. J. K.

1014. ζ-Potential and the Lyotropic Series. D. R. Briggs. *J. Phys. Chem.* 32. *pp.* 1646–1662, *Nov.*, 1928.

Series of ions are shown to affect the ζ-potential at an inert interface (cellulose-water) in the orders of their mobilities which are inverse measures of the lyophility (medium-loving) capacities of these ions in water. It is from this relative lyophility of ions for the phases of the system in which they are distributed that the ζ-potential arises, and it is in this property of the ions that the lyotropic effect of ions has its theoretical foundation. The effect of a salt solution upon the ζ-potential is a function, not alone of the ion carrying the opposite charge to that of the colloid, but of all ions present in the system and to which the interface is accessible. The ζ-potential is shown to vary with the concentration of the salt solution in the same manner as the variation of the partial molal free energy of a substance dissolved in a solvent varies with its concentration in that solvent, $c = ae^{b\zeta}$ and $c = e^{\overline{F}/RT}$ being the equations defining these similar phenomena. The change in the ζ-potential with ion concentration is, in some cases at least, secondary to other free surface energy changes and not, in itself, the determining factor in the adsorption phenomenon. H. H. Ho.

1015. New Method for Measuring Osmotic Pressure. R. V. Townend. *Am. Chem. Soc., J.* 50. *pp.* 2958–2966, *Nov.*, 1928.

Full experimental details are given for a new method for measuring osmotic pressure applicable to dilute solutions of any non-volatile solute in a volatile solvent. The vapour phase is used as a diaphragm separating the pure solvent and the solution. This diaphragm is permeable only to the solvent. The pure solvent is located within the capillaries of a thin porous plate in such a way that a tension can be applied to the liquid, thus reducing its vapour pressure. The rates of distillation from solvent to solution under different tensions are measured, and these are plotted to give the tension corresponding to equilibrium or the osmotic pressure. J. K.